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SOME NEMAS FROM THE ALIMENTARY TRACT OF THE CAROLINA TREE FROG (*HYLA* *CAROLINENSIS* PENNANT)

WITH A DISCUSSION OF SOME GENERAL PROBLEMS
OF NEMATOLOGY *

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This study is based on material sent for identification by Vernon R. Haber, Department of Entomology, Cornell University, Ithaca, N. Y. The greater number of the frogs from which the parasites were taken were collected by Dr. A. H. Wright in Okefinokee Swamp, Georgia; from near Millen, Ga. (June 10, 1922), and Pass Christian, Miss. (June 14, 1917), and a few were obtained from the Biological Supply Co., New Orleans, La. The material comprised about 59 vials of nemas preserved in formalin. The writer wishes to express his thanks to both Mr. Haber and Dr. Wright for the transmittal of the collection and the kindness with which they gave additional information. He is also indebted to Dr. Cobb for revising the manuscript and for many suggestions, and to Dr. Hall for some helpful remarks. Dr. Chapin kindly gave him a number of specimens of *Oswaldocruzia* from *Cistudo carolina* which made it possible to identify eight specimens of *Oswaldocruzia leidy* Travassos.

The writer was very glad to have an opportunity for a closer study of the parasitic nemas dealt with in this paper. Nematologists sometimes specialize too much on one ecological group, some studying and knowing only parasites of man and animals, ignoring the rest, others working exclusively with free-living forms, and some knowing only plant parasites. This situation is largely responsible for the fact that

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a comprehensive classification of nemas is lacking, and that the views on nemec organization, etc., differ widely among the investigators of the above mentioned groups. This is to a great extent hampering progress. The worker in one of the above mentioned fields should do everything possible to broaden his views by instructing himself in the other fields. To illustrate—in the free-living nemas an interesting sense organ called the lateral organ, or amphid (Cobb), was observed in nearly all forms and was a great aid in identification. This organ was never mentioned in connection with parasitic species until recently; and yet this organ, so specifically developed and situated in every nemec species, will be of much practical interest also to the parasitologist, because it will make possible, or make easier, the identification of larval stages of parasites hitherto not at all, or only with difficulty, distinguishable. One of the most important results of the present investigation is proof that these organs are present in all the forms studied, representatives of the Oxyuridae, the Trichostrongylidae and the Ascaridae. It is at least highly probable, if not certain, that the amphids are chemical sense organs and therefore of overwhelming importance in the behavior of nemas. In a recent important paper Baunacke shows how the behavior and the relationships of *Heterodera schachtii* Schm. to certain plants is controlled by chemical influences these plants exercise on this parasite. The perceptive organs in the latter are, in my belief, without any doubt the amphids, but I shall speak of this problem further on. In science it is true that the first attack on a problem seldom leads to its solution, this coming more often in an unexpected way. The solution of even the most specialized problem becomes more probable the broader the knowledge upon which it is undertaken.

Although only preserved material has been available, the writer has not hesitated to discuss not only the structures of the nematode body, but also their probable functions. Here especially more information is needed. The study of the structure generally evolves basic ideas as to purpose. This again leads to an understanding of behavior, and furthermore very often to clues as to the life cycle, and in applied science to points of possible attack in the case of injurious forms or to possible utilization in cases of forms helpful to man. Unfortunately the present material did not permit a study of the influence of the parasites on the host and the mutual relationship of the host and parasite, since only the preserved parasites were available. The fixation in formalin, although perhaps best for the purpose for which the collection originally was made, was not very helpful for the study of internal anatomy. Lack of time, also, is a reason that some parts of the present study are incomplete and many questions not treated as fully as we should have liked.

The Nemic Fauna Parasitic in the Alimentary Tract and Connected Organs.—Four different nemas were found within the alimentary tract and the organs connected with it, namely:

Cosmocercella haberi n.g. n.sp.

Oswaldocruzia leidyi Travassos

*Agamascaris*¹ *odontocephala* n.sp.

Agamascaris enopla n.sp.

Of these four species, only the first two were found adult, the two *Agamascaris* having been seen only in the encysted larval stage. It may be that *Hyla carolinensis* harbors nemas in other organs, i. e., the lungs, the musculature, etc. The forms enumerated here live exclusively in the alimentary tract and connected organs. That the nemic fauna of these organs is complete with the four species may be doubted, although the number of frogs dissected was large. In the case of *Cosmocercella haberi*, a total number of about 1,087 specimens were collected; the number of specimens of the three other species was rather small, *Oswaldocruzia leidyi* being represented by 8; *Agamascaris odontocephala* by 7 and *Agamascaris enopla* by 2. It is interesting to note how each of these parasites has its special habitat and apparently does not interfere with the other. *Cosmocercella haberi* is an inhabitant of the cecum; undoubtedly it lives there within the digestive matter, apparently feeding on it. A careful examination of the contents of the intestine of the nema revealed no recognizable material, most of the content consisting of small globules as they may occur in the cecal content of the host. It seems, therefore, improbable that this parasite harms the cecal wall or is in any way harmful to its host. The largest number of specimens found within one host was 100.

It is thought that parasitism in the cecum is the first step in the gradual development of intestinal parasitism. Conditions there really must not be so very different from those in ordinary decaying matter as regards temperature, lack of oxygen, etc. Saprozoic life, therefore, is thought to be the starting point at least of a number of intestinal parasites or their ancestors. The way the parasites reach their habitat, in this case, would be directly through the anus, or through the mouth and alimentary tract. Many facts in the life history and behavior of the Oxyuridae, which form a large large of intestinal and also cecal parasites, support this view. In connection with this may be emphasized the fact that the Oxyuridae, phylogenetically speaking, are one of the most ancient groups of parasitic nemas. They show close relationship to the Rhabditidae, which on their part are quite often saprozoic or saprophytic. *Cosmocercella haberi* is viviparous. There are only 1 to 3 larvae found at once in the large uterus and 1 to 5 eggs. The eggs

1. For the generic name *Agamascaris* see p. 29-30.

are of enormous size for a nema. The large supply of yolk the young has at its disposal enables it to develop to a late larval stage within the uterus of the mother. Measurements of intra-uterine larvae show them to have a length up to 0.935 mm. The larvae of the preadult stage present in the material and picked from the cecal content measured about 1.3 mm. I am convinced that these larvae usually do not leave the host of their mother; thus, the very large number of specimens, namely 100, found within the large intestine of a single host can easily be understood, even considering the small number of offspring from one female. It seems improbable that these already greatly developed larvae are fitted for a free-living period outside the host, but none of my observations entitled me to infer the occurrence of poecilogynia as described by Seurat for *Tachygonetria vivipara* Wedl. This Oxyurid which lives in the cecum of *Uromastix* has two kinds of females, the one larviparous and having thin-shelled eggs, the deposited larvae remaining in the cecum, and the other oviparous, depositing thick-shelled eggs which are passed out with the feces of the host. If one assumes that *Cosmocercella haberi* lives within the mass of the cecal content, the question arises as to how these nemas withstand the peristaltic movements of the intestine, i. e., how they withstand the outward movement of the feces. The material does not permit an answer. Is there here some special tropism? One may assume that with regard to metabolism all nemas living in the alimentary tract show similar conditions to those described by Weinberg and others for *Ascaris lumbricoides*, e. g., glycogen is the chief source of energy and valeric acid and carbon dioxid are the end products. It would be interesting to show whether this really is true for all intestinal parasitic nemas, and, if so, what are the conditions in saprozoic and saprophytic forms. The cause of the wanderings of certain nemas during their life cycle, and of host changes, etc., are still in absolute darkness. A purely historical conception or explanation is not satisfactory, because it never explains why a parasite with two subsequent hosts cannot fully grow in the first. Why do not the two *Agamascaris* species found in cysts of the stomach and liver of the present tree frog grow to the adult stage but remain in a larval state until they reach the second host? Growth and final evolution within this latter may take place in a very short time. For these puzzling events only a broad study of the metabolic conditions in nemas of the most different ecological groups, and especially of the various more or less specialized cases of parasitism, will furnish the key. Why has an *Ascaris lumbricoides* larva to travel by way of the blood vessels before it is able to develop and grow in the intestine? It must be because of complete changes of its metabolism during its first larval life. If one compares the food on which a free-living nema feeds with

that of a parasite which lives in the blood or in the digesting masses of the intestine, there is one outstanding point: the free-living forms have, chemically and physically speaking, food of highly complex character, but the food of these forms living within the digesting masses is already decomposed into chemically simpler parts, which in certain cases can perhaps be used directly by the parasite without any further preparation, such as digestion. In this case the intestine is of no more use and may disappear or be used in another way, as a storage organ for reserve material. The Mermithids are a good example of this. Also the present material apparently includes an example in *Oswaldocruzia leidy*, a form living in the small intestine of the tree frog and showing what seems to be a much reduced intestine, no longer entirely functional.

All this proves conclusively that the metabolism of the parasites is of great importance for the understanding of their behavior and life cycle. The real cause of host changes, or equally of organ changes, within the same host is, in all probability, a change in the digestive or assimilating capacity of the parasite. Sometimes a first ontogenetical stage may need food of simpler, a second of more complex, chemical structure, and the reverse condition may also occur. Just how this mechanism works, may for a long time be an unsolved problem. For the study of any parasites and their relationship to the host, it may be of importance to keep this in mind. A knowledge of the metabolic processes of the parasites, and especially of those with host changes, would also greatly help to determine their phylogeny.

As already stated, the number of *Oswaldocruzia leidy* living in the small intestine of the tree frog was small; only a few frogs were infested with this form. In no case was more than one specimen from a single host in the present material. It is of some interest to compare the fecundity of *Oswaldocruzia leidy* and *Cosmocercella haberi*; the two forms represent opposite extremes. The former produces an enormous number of eggs; its ovaries and outlets are filled with them, whereas only a few (up to 6) larvae and eggs are simultaneously found in the female apparatus of *Cosmocercella*. Undoubtedly the life cycle of *Oswaldocruzia* must be such that only a few of thousands of eggs develop to the adult stage. The eggs of *Os. leidy* are apparently deposited with the embryo already in a rather advanced stage of cleavage. They may reach their full larval growth after being passed out with the feces of the host. In connection with the egg production, it may also be of some interest to compare the female sexual apparatus of the two forms; the higher capacity and development of that of *Oswaldocruzia* is pronounced. Not only the ovaries show the difference, but also the outlets (compare Fig. 20 with Figs. 38 and 43). Both forms have an ovijector, but that of *Oswaldocruzia* is much more strongly developed, showing the formation of a vagina, a vestibule, a

varnish gland, a sphincter and a funnel, whereas in *Cosmocercella haberi* only a separation of the ovijector into a vagina, a sphincter and a funnel can be seen.

Unfortunately one cannot say anything about the exact place *Oswaldocruzia* occupies within the intestine. It may be that it is fixed with the mouth part on the intestinal wall. The way it feeds is also obscure; I noticed only once a very small amount of a finely granular substance inside the first part of the intestine. The morphological study of the latter seems rather to prove its non-function, or at least its very restricted digestive function. Whereas the esophagus shows no sign of unusual appearance, the intestine, even in total preparations of the parasite, is somewhat abnormal because of its transparency, its thickened cutinized wall around the narrow lumen of its first part (Figs. 32, 36, 37) and the strange localization of its channel near the surface of the organ in certain regions. A series of cross sections (Figs. 36, 37, 42, 44-47, 50, 53, 56) shows this much better. The cells of the intestinal wall, if they may be recognized as such, are very indistinct and often abnormally large with a thickened wall, a small amount of protoplasm and a rather spongy appearance. The lumen throughout is very narrow. In about the first third of its total length, the internal wall, as already mentioned, is strongly cutinized and thickened; the so-called "fibrilläre Kutikularsaum" of other forms is completely lacking, and the cuticular basal membrane of other forms (compare Fig. 29 with Fig. 36) transformed into the above mentioned thickened wall. Only after this thickened basal membrane is reduced to its normal size does a "fibrilläre Kutikularsaum" appear, as shown in figures 45-47. This raises the question as to how *Oswaldocruzia* feeds. Referring to what was said earlier in this paper, the present parasite lives in a medium where food of relatively simple chemical structure is abundant and of which the parts are in solution and may be used directly as building stones by the nema-body. It does not need to make these building stones by destroying highly complex food; therefore one chief part of the function of the intestine may fall out. The resorption of the food may go on through the skin, through the esophagus, or partly through the intestine.

The larvae of the two *Agamascaris* species observed live outside the digestive channel. They form cysts in the tissues of the wall of the stomach and in the liver (Fig. 1). Of two species present, the one *A. enopla*, was represented by only 2 specimens; the other, *A. odontocephala*, by 8 specimens. From the considerable range in size of the latter, it is evident that this species at least grows inside a cyst. Each cyst contains a single specimen, but two cysts may be found close together as represented in figure 1. With regard to the method of feeding, one finds different conditions from those mentioned above.

It is not known whether such encysted parasites take food exclusively through the mouth and alimentary tract, or whether the skin plays a certain part. The food itself consists probably of blood entering through the surrounding tissues and of secreted fluids of the latter. Referring to the presence in both larval forms of tooth-like weapons on the head, one might think these are a means for stimulating the bleeding or secretion of the surrounding tissue. In *A. odontocephala* there are four of these teeth-like formations (Figs. 60, 61) and *A. enopla* has a single one (Figs. 62, 64) located dorsally well outside the mouth, and having absolutely the shape of a tooth. This feature of *A. enopla* is undoubtedly what was long before known and termed a larval tooth and will be lost in the adult stage. The four tooth-like elevations of *A. odontocephala* are of a different nature in that they may form a feature of the adult. They are located submedially just outside the papillae and have a rounded shape. This cephalic armature may also be used by these nemas as a means for penetrating the host tissue, either to reach the place where the cyst is formed or to leave it.

Hyla carolinensis is doubtless only an intermediate host for both these Ascarids. The definite host is probably an animal feeding on the frog, perhaps a snake or a bird. The descriptions therefore are only provisory. The cysts consist of connective tissue and the nemas are located inside in spiral windings.

THE CUTICULA-HYPODERM TUBE OF NEMATODES

One of the forms dealt with in this paper, *Cosmocercella haberi*, has on its surface what is called a lateral membrane or lateral wing. It is a wing-like, or membrane-like, thickening of the cuticula along the lateral line, beginning shortly behind the head end and ending near the anus (Figs. 10, 25, 27, 28, 29 and 31). In the present form the structure is not very pronounced, but there are other nemas in parasitic, as well as in free-living species, in which it is much more developed. As far as I know, the function of this structure has never been discussed. It may therefore be well to say a few words about it. In my opinion there are three possibilities: 1. As is known, the chief locomotion of nemas takes place by a serpentine movement in the dorso-ventral plane of the body. All thickenings along the lateral line, as the present lateral membrane in *C. haberi*, could be said to increase the elasticity, flexibility and strength of the fulcral parts of the exoskeleton, thus preventing any folding of internal structures and furthermore acting as a base for the action of the muscles, which consequently have an oblique position to the lateral line, the lateral chord, the lateral membrane. 2. This membrane also enlarges the swimming surface, or may be used as a kind of steering apparatus, a keel. Compared with the fins of fish, it would correspond to the dorsal, and in some forms also to the ventral, fin, if

single. It may be remarked that the lateral plane in the nematode body, that is the plane from one lateral membrane to the other, is most often placed in the direction of gravity, so that the undulating movements in the dorso-ventral plane are made horizontally, but in swimming freely through the water they may be made vertically and then the lateral membranes be used as fins as in the flat fish. Whereas the fish body in general is flattened, this occurs only exceptionally in the nematode body, e. g., in *Carnoya vitiensis* Gilson where a very large lateral membrane is also developed. The fact that the lateral chords,² i. e., the lateral thickening of the hypodermis, are the best developed of all with regard to size and strength, supports this view. The tendency to strengthen the lateral parts of the exoskeleton is such that it can be clearly seen and mechanically understood, because the lateral parts lie in the lateral plane to which the plane of the serpentine movements stays rectangular.

If in certain nemas (Mermithidae), the lateral chords and thickened parts of the cuticula are shifted slightly dorsad, this is not evidence against this conception. These Mermithids are coiled ventrally in a spiral within the host or in the soil and move very little.

3. These structures can be regarded as resulting from over-secretion along the lateral chord. The cuticula of the nema is secreted by the hypodermis. This latter forms a syncytial tube with the nuclei and the mass of the protoplasma arranged in the longitudinal chords of which the dorsal and ventral most often are very small, whereas the lateral are nearly always large. Undoubtedly the secretory action is more intensive on the surface of those parts of the syncytium just over its nuclei and its mass of plasm. This would lead to an accumulation of cuticular substance which would then form thickenings like those represented in *C. haberi*. Very often there exists not only a single lateral membrane, or wing, but two, one approximately along each border of the lateral chord. They are called sublateral wings (Cobb), or membranes (see text Fig. 3), and are perhaps associated with a biserial order of the nuclei of the lateral chord.

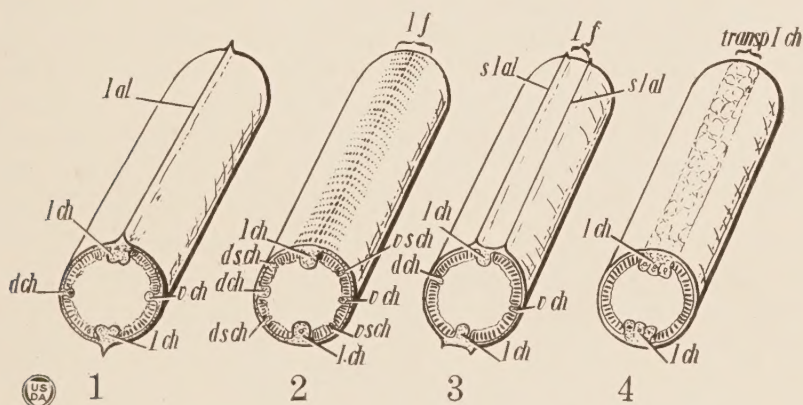
In *Oswaldocruzia leidyi* here described, wing-like structures are not only found on the lateral surface of the cuticle, but also are present all around the body, numbering up to 40 and being equidistant (Figs. 36, 37, 42, 44-47, 50, 53, 56, 57). Seen with low magnification, they give the impression of longitudinal striation. If also in this case a function has to be suggested, it could be embodied as follows: the cuticula plays the rôle of an exoskeleton and has the form of a tube. Such a tube gets its utmost strength from the smallest amount of material by construction like the present. But this multitude of wings, or longitudinal

2. Term latterly used by Dr. Cobb for the German "Längswulst."

ribs, is probably a result of some special condition of pressure and tension in the hypoderm-cuticular tube during the time of moulting and is a special case of striation. Similar conditions may lead to other sculptural ornamentation of the cuticula as found in so many free-living forms (Chromadoridae, etc.).

THE TERMINOLOGY OF THE CUTICULO-HYPODERM TUBE

It is wise to be more exact in using terms of morphological and anatomical significance in nematology. Many efforts of this nature have been made in the past by Cobb. In an earlier paper (1919) the writer



Textfigure A

Diagrams to explain the meaning of the terms: *Longitudinal chord*, *lateral membrane* or *wing*, *lateral field*, etc; *Chord* is any longitudinal thickening of the hypodermis; a *field* has two dimensions and may have various kinds of markings, such as little points as shown in Fig. A2, or it may also be defined by special formations, e. g., sublateral wings as in A3; *lines* are only ideal terms of orientation; *d ch*, dorsal chord; *d s ch*, dorsal submedial chord; *l ch*, lateral chord; *l al*, lateral membrane; *l f*, lateral field; *sl al*, sublateral membrane; *trans l ch*, lateral chord shining through the cuticula and producing the impression of the presence of a lateral field *v ch*, ventral chord; *v sch*, ventral submedial chord.

called attention to the illogical use of the terms, "lateral line," "submedian line," "median line," etc. He once more wishes to emphasize that a line has no diameter, no thickness, no height, no breadth or width, and that the term should only be used as an ideal or mathematical term of general orientation. What in the past and present was and is termed "line," in nematode morphology and anatomy, is a jumble of different things. The adjoining text figures, A 1-3, are self-explanatory and show best how these different things may be so designated that even a beginner will understand the meaning.

HEAD SENSE ORGANS OF THE FOUR PARASITES

The study of the head sense organs in the four present species interests me much in view of a comparison with the same organs in free-living forms. By head sense organs is meant the labial and head papillae and the lateral organs, or amphids. The study of these organs is not only important for the establishment of homologies between parasitic and free-living nemas, but also, as already said, of great practical use in identifying larval and even adult nema forms and understanding their behavior and physiology. Furthermore, if the amphids are sense organs common to all nemas, this is evidence against any relationship of nematodes to arthropods.

The head sense organs often are located with difficulty, especially the amphids and the labial papillae. For the study of the former one is recommended to look at the head of the nema not only from the lateral aspect, as is usually done, but to turn the head end so that a profile view of the amphids may also be seen. This latter combined with the lateral view gives, in most cases, a fairly good idea of the structure of a given amphid. A further help is a front view of the head; after beheading with a sharp knife, the head is placed front-side upward on a slide in heated glycerine jelly of a thicker consistency than usual. Such preparations can be made by any skillful worker even from small nemas, and as figures 4, 35, 61, 64 show, they are very instructive for the study of the structure of the mouth cavity and are sometimes the only means to locate labial papillae and amphids with certainty.

In a former paper (Steiner, 1923) I have noted the presence of amphids in an Oxyurid, namely *Aplectana kraussëi* Steiner. Martini had surmised their nature as organs of taste even before that in *Oxyuris curvula*, but did not homologize them with the lateral organ, or amphid, of free-living nemas. *Cosmocercella haberi* is the third species and the third genus of the family in which the amphid is known.

Figures 2, 3 and 4 give a lateral, medial, and frontal view of the head end of *Cosmocercella haberi*. There are 6 labial papillae, each of the 3 lips having two; there are also 4 submedian papillae and two amphids. Though altogether there are 12 sense organs, they represent only 3 types in structure, and perhaps also in function. The labial papillae are very small and can only be seen distinctly in a front view (Fig. 4). Their structure seems to indicate that each contains a single nerve ending. The submedian papillae are very different; they perhaps are compound organs, as figure 4 plainly suggests. There is a cutinous structure distinctly visible in lateral and median view. The two amphids have a strictly lateral position and each is a calix or pouch-like structure, whose outlines are best conceived by mentally combining the views shown in the three figures. The fixation and preservation of the speci-

mens was not good enough to enable one to recognize all the details. The entrance has an oval shape and leads into a rather narrow, but long, pouch with somewhat thickened walls. At the end of the pouch there begins a swelling which represents, perhaps, the gland found in other forms, and in the center of this gland one can see a bundle of nerve fibers. Unfortunately it is not possible in a total preparation to follow the nerve to the nerve-ring and to find out also how the large cell (glandular cell?) surrounding it connects with the nerve. In harmony with what is known of other forms one may assume that the nerves have end organs, so-called terminals (Cobb), or "Endfasern" (Hagmeier, 1912) within the pouch; but they were not seen here probably on account of the insufficient fixation. With regard to the function of these sense organs, I consider the labial and the submedian papillae as organs of touch; the function of the amphids will be discussed later. It is interesting to note the difference in the two kinds of papillae, the one is situated on the three seemingly very mobile lips, and the other is rather stiffened by cutinous structures and therefore not so mobile. Judging by the well pronounced incision separating them (Fig. 3), the lips must be very mobile.

In *Oswaldocruzia leidy* of which the head is shown in figures 34 and 35, the number of the sense organs is smaller. I could see only 4 submedian papillae and two amphids. On account of the vesiculated condition of the cephalic cuticula in this species observation and study of these organs is rather difficult and I understand that no facts were given by earlier investigators concerning the head papillae here. The submedian papillae are situated in small grooves between, the cuticular swellings, but the amphids, strictly lateral, form small elevations. In each amphid a small oval opening leads into a tubular, rather long pouch, at the end of which the swelling mentioned in the foregoing species occurs. A number of fibers, certainly terminals, could be seen inside the pouch, recalling the same organs in Mermithids and certain free-living nemas. I was not able to get a satisfactory median view of these organs because of the vesiculate condition of the cephalic cuticula, but the frontal view (Fig. 35) affirmed this conception, and, in this view, the terminals could also be seen (Fig. 35) in one of the amphids. The three lips seemed to be without special sense organs. This is the first time amphids have been observed in a representative of the Trichostrongylidae and I think it indicates that they are present in all members of this family.

Most interesting were the two larval Ascaridae (Ascarinae). After what Goldschmidt wrote concerning *Ascaris lumbricoides*, there is little question that all Ascarids have amphids. I was astonished, however, to see how well developed these organs were in the two larval species found in the present material and how easily they were recognized as

such. Their structure is so different from normal head papillae that it is astonishing that earlier investigators did not pay more attention to them and simply called them papillae.

To begin with *Agamascaris odontocephala*, a front view of this species is given in figure 61 and a sublateral in figure 60. The mouth opening has the form of a pentagon and apparently there are no definite lips. Four thick, horn-like, or tooth-like, elevations give the head its characteristic form. They have submedian positions and appear to consist largely of a thickened cuticula. The hypodermic tissue enters the tooth-like formation only to a small extent. Examining the head end, one could take these four elevations as four very pronounced papillae. But this would be a mistake, since no nerves could be seen penetrating the cuticula and coming to the surface; yet it is probable that these structures represent rudimentary head papillae. As figure 61 plainly shows, the lip papillae are 6 in number and lie inside the elevations just mentioned. Four of them are submedian, the two others lateral. They have the shape of bristles. The four submedian tooth- or horn-like elevations seem to have rather strongly developed muscles, causing one to think they have an exclusively mechanical function; this will be discussed later. The location of all sense organs in grooves between these elevations speaks also for this conception, since usually the sense organs are placed on the top of projections. It is strange, however, that laterally, where no such tooth-like formation exists, a head papilla is still present. There are two sense organs present laterally outside the labial papillae. They lie close together; the outer one has to be regarded as the amphid. The inner one is, in my opinion, the lateral head papilla; it is shifted somewhat to the dorsal side and seems to be a residue of the former six head papillae, of which the four submedian ones would be the reduced structures inside the above mentioned teeth. The amphid itself has a rather circular opening and forms a pouch-like tube, at the base of which a swelling can be seen, which would represent the glandular cell found in the amphids of other forms. A number of terminals could be seen inside the pouch.

The second of the Ascarinae obtained from the present material, *A. enopla*, showed the head sense organs well only in top view (Fig. 64). When it was seen laterally or medially, the results were unsatisfactory. The mouth opening is somewhat triangular, and there seemed to be three labial papillae, all near the edge of the mouth opening and so very inconspicuous that I still have some doubts about their presence. There are four submedian cephalic papillae; each one has two widely separated nerve endings. The amphids are strictly lateral and are easily recognized by their structure. Here, too, the organ consists of a circular opening, a tubular pouch and an adjacent nerve and surrounding cell; the terminal could be seen inside the pouch.

As to the functions of the head sense organs, in all the nemas, as already said, the labial papillae and the head papillae may be regarded as organs of touch. Concerning the amphids, I have stated in several papers my conception of them as chemical sense organs in adopting the view of zur Strassen (1906). One must class them as a kind of organ of taste on account of the fact that they serve in perceiving the chemical condition of fluids. This does not mean that they must be connected in all nemas with food and the search for food. This may be the function in some species and may not be in others. In *Mononchus papillatus* I came to a conclusion similar to Menzel (see Steiner and Heinly, 1922), that in this species the food seems to be found chiefly by the organs of touch; but in a paper by Buerkel (1900) there are described experiments serving to locate food. Buerkel placed for 24 hours cleaned mussels (*Mytilus edulis*) cut in parts as baits in traps on the bottom of the harbor of Kiel. In other traps he placed pieces of colored glass and other shiny fragments, while traps of a third group were left empty. In the traps with the mussel baits he caught large numbers of *Oncholaimus vulgaris*—up to 61 on a single mussel and many hundreds in one trap. In the empty traps and those with glass and other shiny fragments he caught none. Buerkel, who did not know the presence of lateral organs or amphids in nematodes and who published his paper in 1900, four years before the publication of zur Strassen's paper on *Siphonolaimus* (*Anthraconema*), says that in nemas only tactile organs and eyes are known but that his experiments lead to the conclusion that chemical sense organs must also be present. His experiments are furthermore very significant in that he caught with fresh mussels as bait nearly one and one-half times more specimens of the above mentioned *Oncholaimus* than if he had used decaying mussels. It is known today that the *Oncholaimi* have small but well developed lateral organs, or amphids, and one recognizes in these organs the chemical sense organ Buerkel claimed to be present. Furthermore his experiments suggest that at least in this species this organ serves for searching out food. Another observation of the same kind is mentioned in a paper by Kati Marcinowski (1905) on *Cephalobus elongatus* de Man, a nema-parasitic or semi-parasitic on plants. She found in her experiments that these specimens enter the germinating rye grains only after their contents had become swollen and partly sprouted. She believes that the animals "scent" these parts from certain distances and are thus attracted to the grain.

Similar observations were made by Baunacke with regard to *Heterodera schachtii* Schmidt. In a series of important and interesting experiments he was able to show that the preferred host plants attracted the parasites in some chemical way even at comparatively long distances. He also claims that these nemas must "scent" their preferred growing

host plant and that chemical influences chiefly direct their behavior. His experiments with germinating beet seeds as baits show clearly that numerous other soil nemas are also subject to similar chemical influences and that they all must have an organ of taste (or smell?) which leads them to their food. Similar experiments and results are also described by van Slogteren for *Tylenchus dipsaci* (Kühn). No other organ than the amphids can be found on the nema body that could be postulated as a chemical sense organ.

But the search for food is not the only function this organ has. Zur Strassen first called attention to the difference in size of these organs in males and females of his *Siphonolaimus* (*Anthraconema*). The amphids of the male are distinctly larger than of the female. This sexual dimorphism was later also observed by other investigators in other genera and species, by Cobb, Hagmeier, Hofmänner, Menzel, Micoletzky and the writer. It is very pronounced in some fresh water Mermithidae. Undoubtedly the amphids are at least, in some cases, an organ to help the two sexes find each other; e. g., in some Mermithidae the male seeks the female. The shape and structure of the amphids vary greatly within the whole group of nemas; each species has its own special form, or at least it is located differently from others or may have a different number of terminals or have these longer or shorter, etc. This fact is certainly in support of the conception to regard them as a means to bring the different sexes or members of a species together.

But there are numerous hermaphroditic and parthenogenetic, or syngonic (Cobb) species of nemas and they too have amphids. The above mentioned *Mononchus papillatus* is syngonic, and, as far as Menzel's experiments and those of Steiner and Heinly seem to show, the amphids in this species are not used in the search for food. For what purpose are they here? Since they are well developed they must be functional. This fact seems to be proof that the functions of these organs are not restricted to what was said above. We are today able to say what the essential structures of an amphid are: A pouch or some other cavity (round, oval, spiral-shaped groove, dimple, or furrow) is located on the lateral region of the head or immediately behind it; through the bottom of this pouch or cavity a nerve and the secretion of a glandular cell enter. The nerve forms more or less numerous end organs called "Endfasern" by Hagmeier (1912) or terminals by Cobb (1923). So far as known they have most often the shape of small rods. The glandular cell embraces the nerve at first but is separated farther back toward the nerve-ring. The outline of a scheme of such a typical amphid is given in figure 12.

That there seems to be secretion by the gland connected with the amphid is stated by a number of observers of free-living species and genera on which secreta adhering to the opening of the amphid was

positively seen. As already mentioned, Goldschmidt (1903) gave a good description of the amphids of *Ascaris lumbricoides*. His "dorsales Organ der lateral Papille" is nothing more nor less than my amphid. His "Stützzelle" is my glandular cell. It is interesting that he notices the difference between the "Stützzelle" in these organs and those of the other papillae; he states that it has a different form and above all that the contents are of a granular type. Only in the interpretation of the end organs it seems he was mistaken. He describes the terminals but did not see that they are also located in his species in a pouch-like structure and that this latter is set off from the "Stützzelle" by a constriction. He believes the "Stützzelle" embraces the organ right to the surface opening. In accordance with what is known today about this organ in numerous other forms of nemas, one may believe that his *Ascaris lumbricoides* has a pouch similar to that in the schematic figure 12. His conception that the terminals unite with their ends to form a cone which reaches the surface through the opening seems to me also to be somewhat doubtful. I have seen many forms of amphids but I never have seen these terminals with their ends united. Perhaps Goldschmidt was misled by some adhering secreta which stuck the ends of the terminals together. Zur Strassen (1904) was the first to recognize the homology of the organ described by Goldschmidt with the lateral organ, or amphid, of the free-living forms (see p. 341 of his paper); Rauther (1918) noticed it first for the Oxyuridae.

A very important paper in connection with this problem is undoubtedly Martini's fine monograph on *Oxyuris curvula*. His so-called "Körnerzelle," which he found connected with the lateral nerve of the head, is without any doubt the glandular cell of the amphid. Martini seems to have seen all the structures very well and in the right way. Of all the investigators who have worked on parasitic nemas he is the only one, as far as I know, who saw the pouch of the amphid. On page 432 he calls attention to a "merkwürdigen becherartigen Körper, der im Querschnitt fast kreisrund ist . . . Ihr Gebiet unter der Kutikula ist sehr gering. Es dürfte sich dabei eigentlich nur um den Porus mit seiner nächsten Umgebung handeln." Very significant also is his statement on page 436 where he calls the pouch a "Körnersack." And on page 460 in dealing with the sense organs and lateral nerve, he writes: "Dieser Endapparat, innerhalb des Körnersackes der Körnerzelle gelegen ist wohl nur als der eines Geschmacksnerven zu deuten. Er besteht aus 2 Teilen. Jede Nervenfasern nämlich endigt mit einer stark färbbaren Platte, auf der ein lang konischer, ebenfalls stark färbbarer Zapfen steht. Dicht nun unter dem Porus der Körnerzelle enden diese Schmeckstäbe mehrerer Nerven zu einem Bündel vereinigt."

"Etwas weiter hinten, also tiefer im Innern des Körnerbeckers endigt nun noch eine mächtige Faser. Diese Endigung liegt dorsal von dem

geschilderten Nervenbündel und ist einheitlich, aber wohl ebenso breit wie die aller andern Nerven zusammen. Auch hier dient eine tief dunkel tingierte Platte als Grundlage des Endzapfens, aber dieser erscheint nicht solide, wie die Einzelzäpfchen des vorderen Apparates. Vielmehr bildet hier der sehr lang konische Endapparat nur die Hülle für einen kuppelförmigen Raum, in dem Gebilde stehen, die sich wie Cilien ausnehmen."

Undoubtedly both, or at least some, of these two described parts belong to the amphids. Perhaps there is already a separation into two distinct parts on account of the double or multiple function of the organ. The amphids of the Sclerostomidae seemed of special interest. In studying the monograph of Looss (1901) one can see that the so-called "head glands" of this author are homologous with the glandular cell of the amphids and that the nervous parts of it are what Looss calls "the thicker terminations of the lateral papillae (1901:63)." The most outstanding fact, however, seemed to be the enormous size of the glandular cells of the amphids in this group of parasitic nemas. They may extend back to near the tail end and even have branches leading to the dorsal and ventral side. Remarkable also is the fact that in *Triodontophorus* the nerve lies within the body of the gland from the terminal pouch down to the nerve-ring.

In the same author's monograph of *Ancylostoma duodenale* Dub. (Looss, 1905), the so-called "cephalic glands" are also homologous with the glandular cells of the amphids. There seems to be a very well developed amphid pouch in this species, judging from the drawings by Looss. It is interesting to remark in connection with this that Cobb (1923) in a recent paper describes the pouch and terminals of the amphids of *Nectar americanus*. One cannot close this discussion without referring to papers recently published by Stefanski (1917, 1922). This author performed a series of experiments to determine by intravital staining the excretions and excreting organs in nemas. He used three different kinds of stains, namely indigo-carmin, neutralred and ammoniacal carmin. His results are interesting because he was able to show a number of cells of apparently glandular character, hitherto only partly known as such. However, I do not support his conclusions that all these glands have excretory functions as he seems to think. This is not the place to discuss his results in full, but I may say a few words about his interpretation of the functions of the lateral organs, or amphids. His "glandes excretrices" and "tâches ovales formées des grains de carmin" in the head ends of *Rhabditis tenuicaudata* Menz. and Stef., *Rhabditis nudicapitata* Stef., *Rhabditis longistoma* Stef., *Rhabditis varsaviensis* Stef., *Diplogaster ornatus* Stef., etc., are in my opinion nothing else than glandular cells connected with the amphids; there is no doubt about that. In his *Diplogaster* sp. *Plectus tenuis* de Man, etc., he noticed

himself that he got parts of the lateral organs, or amphids, stained, and attributes, at least in these species, an excretory function to the amphids. This, I believe is a mistake; by the aid of his staining methods Stefansky seems to have seen one part of the amphids—the gland—but did not find that there were highly developed nervous structures closely connected with it. I can hardly believe that in our nemas an excretory function is united with a sense organ. Stefanski, as I believe, makes a mistake in concluding that every gland which he has stained in his experiments is excretory. He admits himself that it is doubtful to conclude that the “glande vulvaire” of *Diplogaster bernensis* Steiner has excretory functions even though he succeeded in staining it.

The amphids are without doubt complex organs, the functions of which may not be confined to what was stated above, but that the secreta they produce are excreta has not yet been proved. One may ask why the amphids, that is the pouch of the terminals, are so inconspicuous and comparatively so much smaller in parasitic nemas? If they are chemical sense organs, as is assumed, the reason is perhaps as follows: One may say it is a rule that in nemas living in *concentrated solutions*, e. g., in the alimentary tract of some host or in its tissue or body fluid, the amphids will only have a small opening—the whole organ being often very inconspicuous. This is also true for rhabditoid and similar forms living in decaying organic masses. On the other hand, many freshwater and marine forms have relatively large and wide amphids. The soil inhabiting forms do not have them so large, possibly on account of the mechanical action of the medium they inhabit. Only the Mermithidae seem to constitute an exception, in that in being body cavity, or more exactly, blood parasites, they have large, even huge, amphids. But here one has to take into consideration that in the post-parasitic stage they live free in soil or fresh water. It is very significant that the fresh-water Mermithidae have, as a rule, very large, even huge, and wide open amphids, whereas those of the soil-inhabiting forms are small, sometimes even inconspicuous, and the opening narrow. Undoubtedly the chemical substance secreted by the glandular cell of the amphids will be more diluted in a pond or any water than in the soil, and the possibilities for mechanical injuries are less; one may believe that for this reason these organs are often so much larger in marine and fresh-water nemas.

I found just in front of the esophageal bulb of *Cosmocercella haberi* cells of undoubtedly nervous nature, which seem of some interest. A sketch of one of these cells is represented in figure 14. It is an isolated ganglion cell with branches as they occur in a primitive nervous system, e. g., in the coelenterates; this cell is located dorsad or slightly subdorsad of the esophagus. Apparently other cells of similar nature are connected with it; unfortunately it was not possible to get more

information. Perhaps here is a part of a nervous reticulum. I have noticed similar cells also in some other Oxyurids. Judging from figure 3, pl. XX in Galeb's paper (1879) such a nervous reticulum must be well developed in *Oxyuris blatticola* Galeb. It would be well to pay attention to these facts. Perhaps the Oxyuridae show this structure best on account of having the most ancestral character of all nemas.

The Retractor Spiculorum, a Striated Muscle in Cosmocercella haberi

As far as the writer knows, hitherto only the esophageal muscles of certain species of nemas have been known to be striated. The nematode musculature is specific in its character and exclusively smooth so that any exception is of much interest. Figure 15 is a sketch of the male tail end of *C. haberi*. There are two spicula and a gubernaculum present. Proximally the spicula are attached to the body wall by means of a large and powerful muscle. This muscle is especially large in the present species as compared with that of some other forms and deserves special attention because of its distinctly striated nature. The muscle is multinucleate; the contractile fibers occupy the ventral side while the plasmatic bodies with the nuclei are located dorsally. The general shape therefore is that of a "nematoid" muscle cell. The contractile fibers show large anisotropic parts alternating with small isotropic ones, these latter being separated again into two smaller parts by an intermediate membrane (Fig. 16). Therefore they are not of the most primitive striated type, which would have only an alteration of isotropic and anisotropic parts. This retractor spiculi of *C. haberi* is of a more advanced differentiation, since an intermediate membrane is present. It seems strange that these retractores spiculorum should have departed from the conservatively retained smooth character of the nematode muscle. Unfortunately I am not able to state whether or not the protractor spiculi is also striated; perhaps it is.

As shown in figures 22, 30 and 31, the spicula form round tubes which glide, each in a separate channel of the gubernaculum. With regard to the exact function of the spicula during copulation, the general conception seems to be that they are used as means of fastening the male to the female, to help to open the vagina of the latter and in some cases even to serve as a conducting channel for the sperm. It is generally agreed that a smooth muscle acts slowly but with increased efficiency and a striated muscle comparatively quickly but not so efficiently. The presence of such a large and striated retractor spiculi in *C. haberi* seems to point to the fact that at least the retraction of the spicula is rapid. It is generally thought that if the spicula are once inserted into the vagina, they stay in the protruded position until the end of copulation. Perhaps this is not true for all forms and I really do not think that morphological conditions, as they are described here for *C. haberi*, support this con-

ception. Here at least the spicula may be moved forward and backward repeatedly and then only can the presence of a striated retractor of this size be understood. Very few facts, of course, are known yet with regard to copulation of nemas and how it takes place. Even if by chance a copulating couple is found, the function and activity of the different organs involved are hard to observe. As far as the writer knows, Maupas alone observed in his *Rhabditis icosiensis* that the male moved the spicula forward and backward while in copula. This seems in support of the above mentioned conception of the reasons for the striated character of the retractores spiculorum in *C. haberi*. It is to be regretted that the condition of the material did not permit a recognition of the structure of the protractor spiculi. In *Rhabditis icosiensis* the movements noted, were thought to have an exciting effect upon the female, because the point of the spicula touched again and again the vulvar lips.

Although the general shape of the spicula is about the same throughout the nemas, there is much variation in detail in the families, genera and species, the form being more or less curved, longer or shorter, more or less tubular or channel-like, slender or thick, pointed or blunt and cutinized. If one compares *Oswaldocruzia* with *Cosmocercella* with regard to these organs, there is much difference, the spicula of *Oswaldocruzia* being thick, with a multitude of ribs, curves, outgrowths, points, etc., while those of *Cosmocercella* are simple, long and curved conical tubes with rather narrow points. I doubt that all these structural changes even between closely related species are only an expression of mutual morphological fitness of male and female organs. There are usually no such differences to be seen among the female organs of related species. I think therefore that the functions of the spicula must be of rather a complex nature and may be also greatly varied among different nema genera and families; they may be a means of anchorage of the male, they may be stimulating organs, they may serve to put the sperms into the female uterus, or as channels and conductors. But in any case, they serve to widen and open the vaginal lumen of the female, which normally is tightly closed, the vagina having well developed circular muscle fibers. With regard to the exact action of the spicula in thus opening the vagina, as e. g., in the present *Cosmocercella*, it must be thought that the spicula not only enter the vagina, but distend it to such a degree that the spermatazoa can pass. Once being introduced in the vagina they must separate from each other in order to make a channel or tube for the spermatazoa, which are of comparatively large size in this species. How this is done, I am unable yet to see. It may be that the so-called bursal muscles not only serve to move the spermatazoa down the ejaculatory duct, but that their pressure even forces the spicula

to separate in order to let the former pass. In many nemas not only bursal muscles, but also circular muscles around the ejaculatory duct, are present apparently to strengthen this action. In *Oswaldocruzia*, where the spicula are comparatively short, it is hard to see how they could be separated from each other in order to make way for the spermatazoa if they are protruded. The protractor spiculi, the action of which may also distend the vagina and separate the spicula, seems to not to be able to do this. Therefore, I rather believe that here the spicula have such a ridged surface that the ribs and edges form a hollow passage wide enough to let the spermatazoa through, which on this account are much smaller here than in *Cosmocercella*.

Another interesting problem is the question of how the mass of sperm is divided into the two branches of the uterus in case the female organs are double. As far as I have seen, the allotment seems always to be an equal one and there may be a mechanical way to bring this about. Is the one spiculum directed to the one, the other to the other branch, or are both alternately directed first to the one and then to the other? Perhaps all these methods are to be found in nemas. Once placed in the uterus the spermatozooids move themselves in the receptacula seminis, since they are capable of amoeboid movements. It is interesting to see that in *C. haberi* they all had the same orientation, the head end directed toward the oviduct, showing clearly that some chemical influence brings about this tropistic reaction. *Oswaldocruzia* belongs, with regard to the male tail end, to the bursate nemas, whereas *Cosmocercella* is the representation of a new type. Here the whole region of the left and right side of the male sex opening is vesiculated. The cuticula is lifted from the sublayer and forms two elongated, somewhat flattened bubbles. A few nerves with surrounding tissues cross the lumen and support the outer walls of the swellings. The terminals of these nerves are apparently organs of touch and homologous with the papillae of other Oxyurids. The whole is an apparatus to enable the male to find the vulva of the female. In other Oxyuridae simple papillae often well elongated and of finger-like shape are present. The vesiculate condition of the whole area occupied by these papillae in *Cosmocercella* raises the question of its function. The tendency to form a vesiculate region around them is even found on the papillae of the tail. What is the meaning or use of these structures? They undoubtedly help to stabilize the elongated papillae, which, without this, would stand out from the body bare of any protection. Therefore it allows a greater length and accordingly a greater efficiency of these papillae. To appreciate this one needs only to remember that the male has to find the vulva of the female exclusively with the help of these organs of touch. If the two sexes have approached each other, the male will encircle the female with his

tail end at any place, and then with the encoiled tail run up and down the female body until encountering the vulva. As I have seen in some Rhabditis, this often takes quite a long time. The better a sensorial outfit the male tail end has, therefore, the better copulation is assured.

The bursa of the bursate nemas, e. g., *Oswaldocruzia leidyi*, is also chiefly a means for locating the female sex opening, and the bursal membrane a means for supporting the papillae, which are long and finger-like here and form the so-called ribs of the bursa. The bursa and like structures are first exclusively highly developed sense organs, organs of touch and only secondarily organs for mechanical aid to copulation.

Sex Ratios in Cosmocercella haberi

On account of the large number of specimens of *Cosmocercella haberi*, the present material permits an estimation of the numerical relationship of females to males in this species. It is known that in the nemas the sex ratio is very variable, sometimes even within the species of one genus. In *Cosmocercella haberi* a total of 1087 specimens was inspected; of these 370 were not sexually mature. Of the remaining 717 adult specimens 559 were females and only 158 males. If one applies Hertwig's sex ratio number in setting for the females the number 100, the sex number of our species would be 28.2, that is, to every 100 females there would be 28.2 males. It is of some interest to compare also the ratio of the sexes in different specimens of the host. In one case there were found 11 males to only 4 females, the males therefore greatly outnumbering the females. Another case showed only 9 males to 52 females. Twice hosts were found harboring females only, namely 15 and 12 females respectively. In one case only a male was found; whereas in another host 31 young were seen, but no adults. The conclusion is that it is hazardous to judge the sex ratio when having only specimens from one host; the sex ratio varies much in various specimens of the host.

All the female nemas examined were impregnated. Without any doubt *Cosmocercella* is a bisexual form. One may assume that one male usually serves several females. Since the eggs of these latter are large and the young develop in the uterus of the mother, the latter being viviparous, one female needs perhaps only one impregnation and has only a restricted number of young. The number of spermatozoa in the uterus of the female is never high, perhaps only about 50 to 60 in both together.

Hyperparasites in Cosmocercella haberi

A number of specimens of *C. haberi* showed in the intestinal wall somewhat enlarged cells filled with a great number of elongated bodies (Fig. 19). Undoubtedly these are of parasitic nature, and they seem

to belong to the Coccidia. If this conception is true, then here is one of the very few cases already known of hyperparasitism in parasitic nemas, perhaps the first one of animal nature; the others being due to fungi.

TAXONOMY OF THE FOUR PARASITES

Cosmocercella nov. gen.³

Diagnosis: Oxyuridae with lateral wings, 3 lips, 6 labial papillae, 4 head papillae, 2 amphids (lateral organs), narrow naked mouth cavity, valvular apparatus in the terminal oesophageal bulb, excretory pore ventromedian behind nerve-ring; vulva near middle of the body, caudad and orad outstretched, reflexed ovaries; single reflexed testis, paired rather long spicula of equal size and with gubernaculum; vesiculated bubble-shaped bursa on both sides of the anus; with vesiculated pre-anal accessory copulatory organs, so-called plectanes and pre- and post-anal copulatory papillae.

Type species: *Cosmocercella haberi* n. sp.

Remarks: The present genus should be placed in the fourth group of the provisory system of the Oxyuridae according to Railliet and Henry (1916) since the males have two spicula and a gubernaculum. The genera already placed in this group are:

Cosmocercera Diesing 1861 which differs from the present genus in the absence of a vesiculate bursa.

Aplectana Railliet et Henry 1916 which differs in the absence of vesiculated papillae (plectanes) and a vesiculate bursa in the male.

Falcaustra Lane 1915, which differs in the absence of a vesiculate bursa, of plectanes, and has a mouth cavity of different structure.

Amblyonema v. Linstow 1898, which differs in the absence of a vesiculate bursa and plectanes, in the bluntly rounded tail in both sexes, and has three teeth in the mouth cavity.

Isakis Lespes 1856 (*Skrijabin* 1916), which differs in its armed lips and its esophagus of which the anterior part has as large a diameter as the bulb from which it is set off by a constriction.

Carnoya Gilson 1898, which differs in its strongly annulated cuticula, which bears prickles on the 12-15 anterior annules, in its esophagus with two bulbs, the anterior immediately behind the pharynx and in the apparently complete absence of all male papillae.

Cosmocercella haberi nov. spec.⁴ [Figs. 1-31]

Habitat: 559 females, 158 males and 370 juveniles in large intestine of *Hyla carolinensis* Pennant.

3. Diminutive of *Cosmocerca* to which genus it is closely related.

4. This species is named after Mr. Vernon R. Haber, who collected the nemas dealt with in this paper.

Measurements: Cobb's formula:

	22.	53.	87.6	
Females	<hr/>	<hr/>	<hr/>	1.88 mm. (n ² -5)
	.6	5.3	3.3	
	24.	50.	92.	
Males	<hr/>	<hr/>	<hr/>	1.76 mm. (n-5)
	4.	4.7	2.9	

de Man' formulas:

Females			Males		
α —18.8	(17.8–20)	} N-5	21.2	(19.6–25.0)	} N-5
β —4.54	(4.3–4.8)		4.17	(3.57–5.0)	
γ —8.1	(7.1–10.0)		12.5	(11.1–16.7)	
δ —53%	(50%–56%)				

²n = number of specimens measured

The body tapers slightly from the beginning of the intestine towards the head but more rapidly behind the anus, the tail having an elongated-conical shape in both sexes and ending in a rounded point. The cuticula is thin and finely annulated; the annules can only be seen within high power. Laterally they are interrupted in a low lateral membrane or wing (Figs. 8, 10, 25 to 31). There are no longitudinal striae. There are four longitudinal chords, the lateral ones larger, the median ones are small.

The head presents three lips, each bearing two inconspicuous papillae (Fig. 4); furthermore there are four submedian head papillae, each with one end apparatus and a cutinized structure of perhaps some protective or supporting function. The amphids are readily seen, even in side view (Figs. 2-4) where they have the following form: an oval opening with a breach or gap in the posterior edge leads to a tubular pouch with slightly cutinized walls; at the base of this pouch the outlines of a large cell attached to it can be seen and numerous fibers cross this cell longitudinally. A profile view (Fig. 3) and a side view (Fig. 2) help to make the exact structure recognizable.

There is no distinct mouth cavity. The esophagus is cylindrical and has a single very large cardiac bulb (Figs. 51, 9). The first short portion of the esophagus just behind the mouth, is really conical; at its base is a region of homogeneous tissue without any radial muscle fibers. A similar region is found a small distance in front of the bulb. These intermediate layers of tissue are also marked by the endings of esophageal glands, which begin at the anterior and end at the posterior layer. The three glands (Fig. 25) are of tubular shape and located one dorsally and the other two right and left subventrally inside the esophageal tissue. They open into the esophageal tube at the level of the anterior region of the above mentioned homogeneous tissue; but strangely enough there seemed to be also outlets at the posterior ends; on account of the insufficient preservation of the animals I was not able to prove the exact

conditions. However, a double outlet of these elongated glands seems rather improbable. In the small portion of the esophageal tube just in front of the bulb there are three other glands, one dorsal and one sub-ventral, as shown in Figure 5. The esophageal lumen is triquetrous throughout its length. The terminal bulb is well set off and is provided with a valvular apparatus with striated plates (Figs. 9, 26, 27).

The intestine shows two distinctly different regions, the anterior half, approximately, having smaller polyhedral cells than the posterior (Figs. 6, 7, 13). The cells of the anterior portion are of darker color, somewhat filled with granules, whereas those of the second portion are lighter, not so rich in content and, most interesting of all, they are of larger size, especially the length is about twice that of the cells in the anterior portion. Cross sections show furthermore that the so-called "Stäbchensaum" of the inner wall of the cells of the anterior portion is far more fully developed than in those of the posterior (Figs. 28, 29). These differences point undoubtedly to very sharp functional changes in the intestinal wall. There are three rectal glands situated just at the posterior end of the intestine; for other details of this region see figure 10.

The nerve-ring can be seen in figure 9. The presence of cells of a nervous reticulum in front of the esophageal bulb has already been mentioned in the general part of this paper. The excretory pore opens half-way between the nerve-ring and the cardiac bulb; the excretory apparatus however seems to be of a rather rudimentary character; a short duct can be seen leading to three or four small cells with large nuclei. The female sexual apparatus is of a well-differentiated nature. The tubular, strongly muscular vagina leads to a sphincter not set off and bound to a rather long "trompe" (Seurat) with a thin epithelial wall. The vagina and sphincter are directed forward and the adjoining funnel is again bent tailwards so that the junction with the uteri is about on the latitude (Cobb 1923b) with the vulva. One of the uteri is directed toward the head; the other toward the tail. The wall consists of a polyhedric epithelium (Fig. 20a). Both ovaries are directed forward; the posterior branch of the female apparatus is again bent forward at the region of the oviduct. The ovaries are very slender and rather short. The adjoining oviduct has the same epithelial structure of polyhedric flat cells as the uterus, but at the joint with the receptaculum seminis there are numerous larger cells of probably glandular function to be seen in its walls (Fig. 21). The eggs are of large size ($205-252 \times 82-109\mu$); they develop fully inside the uterus; the larva up to a length of about 1 mm. stays there. The number of eggs and larva present at once in the uterus is small; 5 eggs or embryos and 1 to 3 larvae was the maximum number seen.

The male gonad is simple and the testis bent backward (Fig. 23). In some males, curiously, the gonad reached nearly to the cardia, but in most of them it had the shape and position drawn in the figure. All the different regions of the duct can be distinguished: vesicula seminalis, vas deferens and ductus ejaculatorius; they are all more or less set off from each other; most pronouncedly the ductus ejaculatorius which is separated by a slight constriction, its strong wall apparently containing muscle fibers. An interesting fact may be mentioned here: between the sperms in the vesicula seminalis and at the end of the testis large bodies of somewhat smaller size than the spermatazoa themselves could be seen in almost any specimen of proper age. They have a compact and bright appearance somewhat reminiscent of the polar bodies of the female. The source can hardly be anything but an irregularity in the cell separations of the ripening stages of the spermatazoa. There are two spicula of equal length (197μ average); slender, with sharp pointed distal endings. The gubernaculum is long and forms two channels for the gliding spicula (Figs. 15, 30, 31). The retractor spiculorum is unusually large. The accessory male copulatory organs consist of "inflated" bursal bladders, one on the left and another on the right side of the sexual opening; they are crossed and supported by several papillae (Nos. 7, 8, 9 and 10 of Figure 15). There is also a ventro-median papilla right in front of the sexual opening between the two vesiculated bursal bladders (Fig. 22). Two more nearly ventro-median papillae (Nos. 5 and 6, Figure 15) are in front of the latter. Four pairs of large vesiculate papillae, so-called plectanes, are found again farther forward, two at the latitude of the proximal ends of the spicula and the other two at about the same distance in front of the first as these latter are in front of the sexual opening. These papillae are ventro-submedian; their size is not quite the same, the foremost ones being the largest. Their structure shows them to be undoubtedly of nervous, perhaps, of a sensory nature. The vesicle is crossed by a nerve with a thick bristle-like end organ (Fig. 17); the surface of the vesicle is roughened by numerous rod-like structures crossing this part of the cuticula (Fig. 18). These plectanes are formed late during ontogenesis and first have the shape shown in figure 24. The position of these organs seems to vary to a certain extent. There are also five post-anal papillae, placed on the tail and the bursal musculature is developed only in front of the anus (Fig. 15).

The Genus Oswaldocruzia Travassos 1917

Travassos, the famous Brazilian helminthologist, founded this genus in 1917 for a small number of species of the Trichostrongylinae, one of the two subfamilies of the Trichostrongylidae (Travassos 1917, 1921, p. 23 of the French text). Only two species are thus far well known,

namely *O. subauricularis* (Rudolphi) and *O. filiformis* (Goeze). Of the six others one is named by Travassos *O. leidy*; it is the only one hitherto known from North America. Leidy, who mentioned it, referred it to *Strongylus auricularis* (*O. filiformis*) and gave no description whatever but named as hosts *Cistudo carolina* (*Terrepene carolina*) and *Bufo americanus*. On account of these hosts and the different geographical distribution Travassos assumed that Leidy's species might perhaps be something new and used therefore the name *O. leidy*. Since this would be the only species of *Oswaldocruzia* hitherto observed in the U. S., I assumed that my specimens of *Oswaldocruzia* might be the same, but was unable to prove it, having no material from *Cistudo* or *Bufo*. Fortunately Dr. Chapin was so kind as to place at our disposal a number of specimens of *Oswaldocruzia* which he formerly collected from *Cistudo carolina* and thought to be Leidy's species (Leidy's original specimens apparently are lost). A close examination proved the present forms to be identical with those from *Cistudo carolina*; thus both have to be named *Oswaldocruzia leidy* Travassos. This species is closely related to *O. subauricularis* (Rudolphi) Travassos 1917.

With regard to the generic characters, Travassos describes a transverse striation at the head end, which is in reality an annulation of the cuticle.

Oswaldocruzia leidy Travassos 1917 [Figs. 32 to 57]

(*Strongylus auricularis* Zeder, of Leidy 1856)

Habitat: Small intestine of *Hyla carolinensis* Pennant.

Number of specimens found: 6 females, 2 males in 8 different frogs.

Measurements: Cobb's formula:

	Nerve- Ring 0.5	Cardia 4.1	Vulva 65.0	Anus 98.0	
Female	0.4	0.9	1.4	0.5	9.9 mm.
Male	2.3	5.49	6.6	50.	98.3
	0.5		1.3	1.8	1.3
					5.236 mm.

Diagnosis: *Oswaldocruzia* with about 40 longitudinal, equidistant small wings on the surface of the cuticle, a rather short, not bent ovijector, dorsal lobe of the bursa separated by a deep incision from the lateral ones and the dorsal ribs with three branches; a ventro-median pre- and post-anal papilla in the male.

The body of the female is very elongated spindle-shaped, being conically reduced at both ends (Fig. 38). The male, however, is only reduced at the head end, whereas the rest of the body is more or less cylindrical. It is very remarkable that the head end of most of the specimens is bent ventrally, a fact also observed by Travassos for his

species. The cuticula is thin, consisting of two layers. As in the other members of the genus, it is swollen and vesiculated around the head end. The vesiculated region is also annulated, but the annulation extends farther back, about twice the distance of the vesiculated region; then the annulation disappears. The head itself is set off from the remainder of the body, being thicker through the vesiculated part. A closer study shows this swelling to be caused by numerous and irregularly arranged cavities of different size within the cuticle, or between the cuticula and subcuticula. As shown in figures 32, 33 and 35, there is a whole network of walls, cavities and irregular elevations, some cavities being larger, others smaller. The surface is distinctly annulated. There seems to be some variation with regard to the whole structure, some specimens appearing to have transverse series of points, and, as shown by the top view, the cavities and the network of the walls are asymmetrically arranged.

Absolutely nothing is known about the significance of these structures. Perhaps they have something to do with the fixation of the parasite on the intestinal wall of the host or the way it takes food. The cuticula of the remainder of the body is longitudinally striated, e. g., has very small longitudinal membranes or wings on its surface. These begin shortly behind the above-mentioned annules of the head end, that is, in the neighborhood of the nerve-ring. The number of these equidistant wings in the middle region of the body is about 40. They are one of the specific characteristics of our species since they are not yet mentioned in connection with other *Oswaldocruzia*. The tail of the female is conical and is of medium length; at the very end in almost every specimen there is a short point to be seen.

There are four head papillae, submedian and somewhat hidden between the anterior edges of the vesiculated swellings described above. The amphids are of the tubular pouch type. The three lips have a thickened interior wall. The esophagus is cylindrical in its anterior half and conical in the posterior, with a pronounced swelling near its posterior end, but not bulbous. The intestine is slender. There are apparently three rectal glands, at least in the female. The distal part of the rectum and the anus of the female have not only a dorsal dilatator muscle but also there is one on the ventral side, of small size. These are rather unusual conditions (Fig. 39).

The nerve-ring encircles the esophagus near the middle. A deirid (Cobb 1923a) or cervical papilla can be seen on each side somewhat behind the latitude of the porus excretorius (Fig. 32). The excretory apparatus (renette or ventral gland) seems to be of some interest. A very large organ resembling somewhat a "U" of certainly glandular structure, lies ventrad and laterad of the end of the esophagus and of the adjoining portion of the intestine (Figs. 32, 40, 54a). Cross sec-

tions (Figs. 36, 37, 42, 44) show well the relations of this gland in succeeding portions of the body. A rather short processus seems to run on each lateral side forward but only to a short distance cephalad of the cardia; similar processi also extend caudad, but they are much longer than the former, the ends rather slender as shown in figure 40. Their posterior ends can be found not so far behind the region where the thickened cutinized basal membrane of the intestinal tube also ends. A middle portion of the gland extends as a compact mass ventrad and laterad of the intestine as shown in figure 54a. I am not able to state whether the gland is unicellular or, as the figure rather seems to show, composed of at least four different parts. Undoubtedly this is a homologue of the so-called ventral gland of many free-living nemas. The pore of the efferent duct lies ventro-median somewhat in front of the cardia but is rather hard to see and the writer at first thought a structure ventro-median behind the nerve-ring was the rudimentary excretory pore (Figs. 32, 54a). There seem to be some signs of the former presence of perhaps three glandular cells in the tail, the outlines of which in some specimens can be seen. The point at the tail end looks very much like a coagulated outflow of these tail gland cells.

The female sexual apparatus is of the amphidelph type (Seurat); the organization may be seen in figures 38, 43-46 and 49-52; the end of the posterior ovary is located at some distance cephalad of the vulva, whereas that of the anterior is placed at the side of the posterior part of the esophagus. The ovaries are bent and curved in many directions, being very long and rather slender. There is a well set off and slender oviduct leading into a receptaculum seminis. The long uterus contains numerous eggs; I counted 66 and more in each one. The connected ovijector was in all the specimens rather short, although not extended to its utmost capacity. The ovijector is connected with the uterus by a short sphincter to which succeeds also a short varnish gland with somewhat globular outlines and then a vestibulum. The wall of the latter is rather thick (Figs. 43, 50-52) and in all specimens its surface is much folded. Both branches of the female sexual apparatus have a common short vagina. The vulva is not prominent but forms a groove on the body surface. The eggs are ellipsoidal with a long axis of 84μ and a short axis of 42μ . The very thin egg shell is apparently secreted by a portion of the oviduct. The eggs begin cleavage in the uterus and are apparently deposited with the embryo nearly developed.

The male sexual organs consist of a single testis, outstretched forward, of long cylindrical shape; a short, well set off vesicula seminalis and a ductus ejaculatorius. There are two symmetrical spicula, the left and right of somewhat different shape (Figs. 48, 54, 55). It is difficult to recognize and to understand their exact organization, there being so many edges, ridges, spines and curves. The color is brown.

Length: 0.162 mm. Gubernaculum absent. Just in front of, and also just back of, the anus is located a papilla. The bursa is well developed and distinctly trilobed; the two large lateral lobes are separated from the smaller dorsal one by a deep and distinct incision. The arrangement of the bursal ribs can be seen in figures 48, 51 and 55. It is much like *O. subauricularis*, the chief difference being in the ribs of the dorsal lobe, which here have only two branches whereas in *O. subauricularis* they have three.

Thus the differences between *O. leidyi* and *O. subauricularis* are rather few and unimportant, the most important being the following: In the former the cuticula has longitudinal ridges which are not described for *O. subauricularis*. The female of *O. leidyi* has two short and not bent ovijectors, whereas in the Brazilian species the ovijector is said to be long, about 0.461 mm., and S-shaped. The male of *O. leidyi* has a preanal and a postanal papilla and a dorsal lobe of the bursa separated by a deep incision from the two lateral; this seems not to be the case in *O. subauricularis*. Furthermore the rib of the dorsal lobe of the latter has three branches, that of *O. leidyi* only two. The spicula seem to be somewhat different in the two forms.

Habitat of *O. leidyi*:
Hyla carolinensis Pennant
 (Small intestine)
Cestudo carolina
Terrepene carolina
Bufo americanus
 Locality: U. S. A.

Habitat of *O. subauricularis*:
 Intestine of:
Bufo musica
Bufo aqua
Bufo ornato
Cystignathus ocellatus
Ceratophrys cornuta
 Locality: Brazil

Description of the Two Larval Ascarinae

I was not able to identify the two Ascarid larvae with any hitherto described adult or larval form. Therefore it seems best to name both as new species and to give descriptions and drawings complete enough to recognize them if later found in larval or adult stage. Investigators often give very inadequate descriptions of larval forms, thinking them not worth closer examination on account of their immaturity. Most often they are simply mentioned as *Ascaris* spec., etc. I hold this practice to be erroneous. This and similar names are a worthless burden to nomenclature and taxonomy unless properly described and named. Both species here described belong undoubtedly to the Ascarinae, ventriculus and intestinal cecum being both absent. But it is rather improbable that the present forms belong to the genus *Ascaris* s. str. As the writer put the problem of the classification of the two present forms before the Helminthological Society of Washington at its October meeting, Dr. Stiles kindly suggested several ways to proceed, among these the creation of a provisory genus for larval *Ascaris* as *Agamascaris*, a proposi-

tion which the writer followed here. (For further information see the discussion in the reports of the meetings of the Helminthological Society of Washington for the year 1923-1924 in *The Journal of Parasitology*.)

Agamascaris odontocephala n. sp.

Habitat: 8 larvae in cysts in stomach wall and liver of *Hyla carolinensis* Pennant.

Measurements: Formula of Cobb.

Cardia		Anus	
7.04	50.	99.	
<hr/>			
.97	1.77	.52	47.37 mm. (38.5—42.0 mm.)

The general shape of the body is rather a slender one, with pronounced reduction towards the head end. The very short, somewhat bluntly rounded tail has a small but fine mucro at its end (Fig. 59). There are fine annulations on the surface of the skin which can be seen at the extremities. The head has four submedian tooth-like, rounded elevations (Fig. 60) with thickened cuticula and with no sense organs on the apex, these being located at its base, thus showing that the purpose of the elevations may be a mechanical one (penetration and perhaps continual injury to the host tissue). There are six labial papillae present (Fig. 61). They are of bristle-form, perhaps because placed somewhat in a retired position at the base of the above mentioned tooth-like elevations. As the front view of the head end and also any side view shows, some tissue enters the elevations, thus forming a kind of protruberance, which, especially in a front view, could be taken for a papilla. However, I never was able to see nerve endings penetrate the cuticula at these places. Therefore, I am not inclined to regard these protruberances lying on the outside of the submedian tooth-like elevations as papillae. It may be that they are remains of a former outer circle of submedian papillae. One could come to this conclusion with regard to the arrangement of the head sense organs as a whole as already mentioned in this paper. My conception is that the inner circle of six papillae is in reality homologous with the so-called labial papillae of other forms, and that the true head papillae are much reduced; the submedian have already lost their nerve endings, whereas these are still present laterally; but signs of rudimentation could be said to be present also in the latter, especially with regard to their shifting dorsad and to their somewhat retired position. The vestibule is pentagonal and leads to a very small mouth cavity; the esophagus has first a cylindrical, but in the posterior part, a conical form with a very pronounced swelling toward its posterior end. The wall of the intestine contains numerous polygonal cells. All present specimens showed the lumen well filled with a dark brown mass,

perhaps blood from the host. The rectum is well set off; a suspensory muscle attaches the end of the intestine to the exoskeleton. The nerve-ring is situated near the head end, about one-eighth of the total length of the esophagus posterior to the mouth opening. The excretory pore could not be located; but an indistinct structure of the kind could be detected near the nerve-ring.

Agamascaris enopla n. sp.

Habitat: 1 juvenile in cyst of liver of *Hyla carolinensis* Pennant, and parts of a second specimen.

Measurements: Cobb's formula:

	1.47(?)	50.	99.7	49,470 mm.
0.13	0.51	1.72	0.25	

The general shape of the body is nearly cylindrical; the cuticula is annulated at the head region and at the tail end. The head is set off from the body by a slight constriction. The tail tapers very suddenly just behind the anus, but very little in the second half, thus forming a finger-like appendix to the body (Fig. 65).

A front view is the most instructive (Fig. 64). There are four submedian head papillae, only with difficulty to be seen in a side view, but which can be seen well in a front view of the head. They are low but broad elevations containing two sensory end organs in each papilla. There are no lateral papillae. The amphids resemble papillae but are distinctly different from the submedian ones, having only a single end apparatus; amphidial terminals could also be seen. The position seems to be slightly shifted dorsad. Three apparently labial papillae are also marked in a rather unusual position; their definite existence is somewhat doubtful. A so-called larval tooth is located slightly sinistro-ventro-submedian.

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STEINER—NEMAS FROM CAROLINA TREE FROG

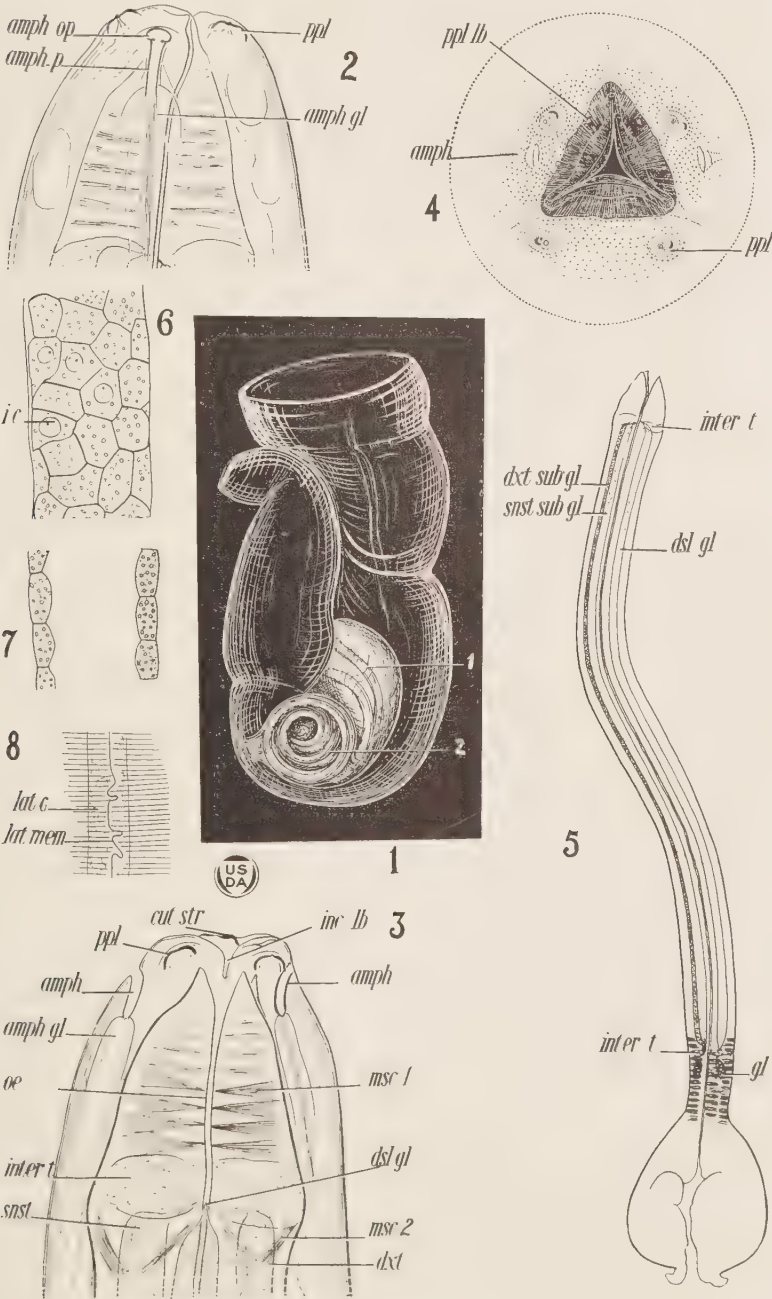


PLATE I

Explanation on other side

STEINER—NEMAS FROM CAROLINA TREE FROG

EXPLANATION OF PLATE I

Fig. 1.—Stomach of *Hyla carolinensis* Pennant with a double cyst caused by larval Ascarids; 1 and 2, nemas therein.

Fig. 2.—Head End *Cosmocercella haberi* n.g. n.sp. in lateral view; *amph gl*, amphidial gland; *amph op*, opening of amphid; *amph p*, wall of pouch of amphid; *p pl*, head papilla.

Fig. 3.—In median view; *amph*, amphid; *amph gl*, amphidial gland; *cut str*, cutinous structure of papilla; *dsl gl*, dorsal esophageal gland; *dxt*, dextro sub-ventral esophageal gland; *inc lb*, incision between the lips; *inter t*, intermedial tissue layer of the esophagus; *msc 1*, radial muscles of the conical part of the esophagus; *msc 2*, muscles of unknown function; *oe*, esophageal tube; *ppl*, head papilla; *snst*, sinistro subventral esophageal gland.

Fig. 4.—Front view; *amph*, amphid; *ppl*, head papilla; *ppl lb* labial papilla.

Fig. 5.—Esophageal glands; *dsl gl*, dorsal esophageal gland; *dxt sub gl*, dextro-subventral gland; *gl*, gland in prebulbar part of esophagus; *inter t*, intermedial tissue layer; *snst sub gl*, sinistro-subventral gland.

Fig. 6.—Surface of anterior part of intestine; *ic*, single cell.

Fig. 7.—Optical longitudinal section through same part of intestine.

Fig. 8.—View of lateral surface of cuticula; *lat c*, lateral chord seen through the cuticula; *lat mem*, lateral membrane or wing, sometimes folded.

EXPLANATION OF PLATE II

Cosmocercella haberi n.g. n.sp.

Fig. 9.—Anterior part of body; *amph*, amphid; *card*, cardia; *cls ex ap*, cells belonging probably to reduced excretory organ; *gl*, gland; *gng cl*, ganglion cells; *inter t 1*, first intermedial tissue layer of esophagus; *inter t 2*, second intermedial tissue layer of esophagus; *int cl*, intestinal cells; *msc valv ap.*, muscles of valvular apparatus; *nrv r*, nerve-ring; *oe dct*, esophageal channel; *oe gl*, esophageal gland; *oe msc*, radial muscles of esophagus; *p ex*, excretory pore; *ppl*, head papilla; *str valv ap*, ribs or striae of valves; *valv ap*, valvular apparatus.

Fig. 10.—Tail end; *cl int*, intestinal cells; *dil an*, dilatator ani; *lat mem*, lateral membrane or wing; *rct cl*, rectal cell; *rct gl*, rectal gland.

Fig. 11.—View of ovijector; *sphnc*, sphincter; *tr*, trompe; *vag*, vagina.

Fig. 12.—Schematic figure of typical amphid; *gl cl*, glandular cell; *ncl*, nucleus of glandular cell; *nrv*, nerve; *nrv r*, nerve-ring; *op*, opening at base of pouch through which nerve enters and also secreted of glandular cell; *t*, terminals; *scr*, secreted adhering to surface of opening of pouch; *w*, wall of amphidial pouch.

Fig. 13.—Surface view of second part of intestine showing two kinds of cells; *ant cl*, anterior cells; *post cl*, posterior cells.

Fig. 14.—Ganglion cell of nervous reticulum.

STEINER—NEMAS FROM CAROLINA TREE FROG

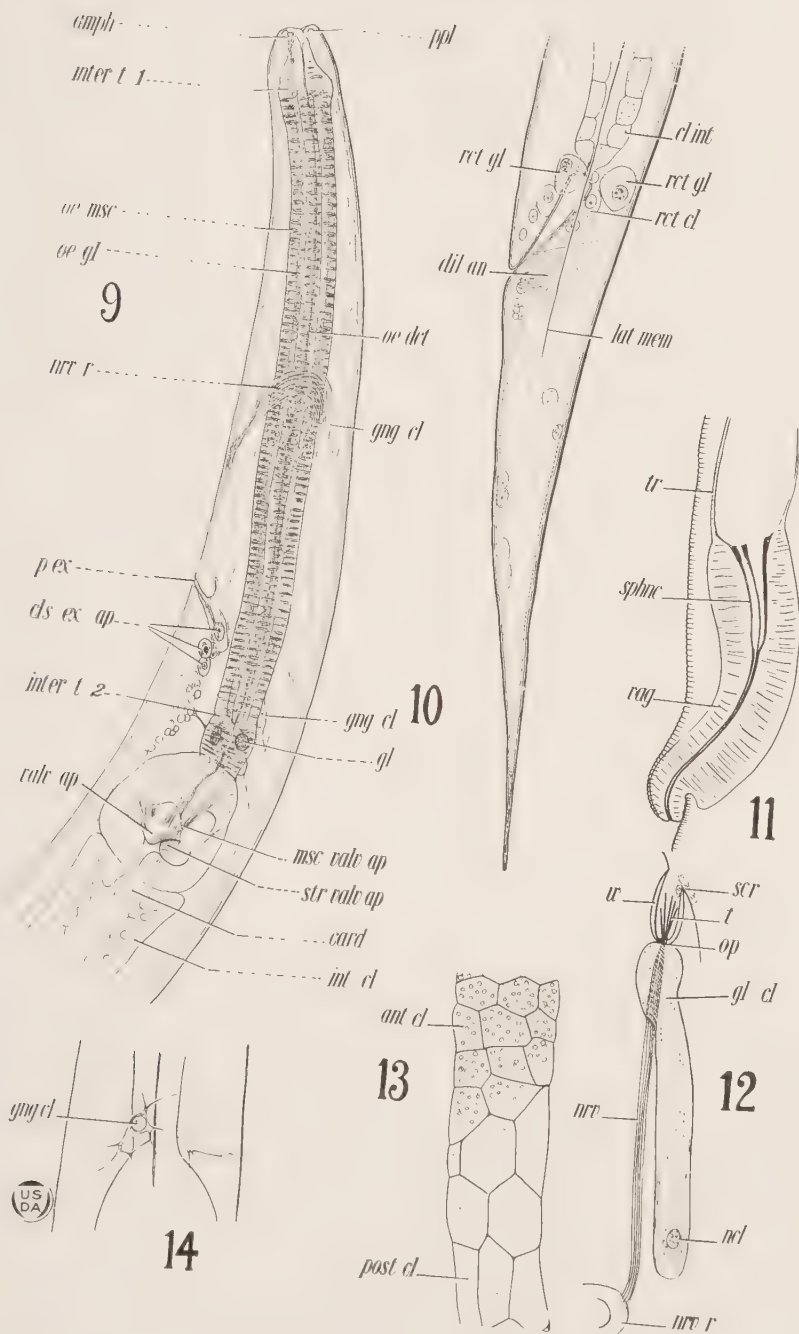


PLATE II

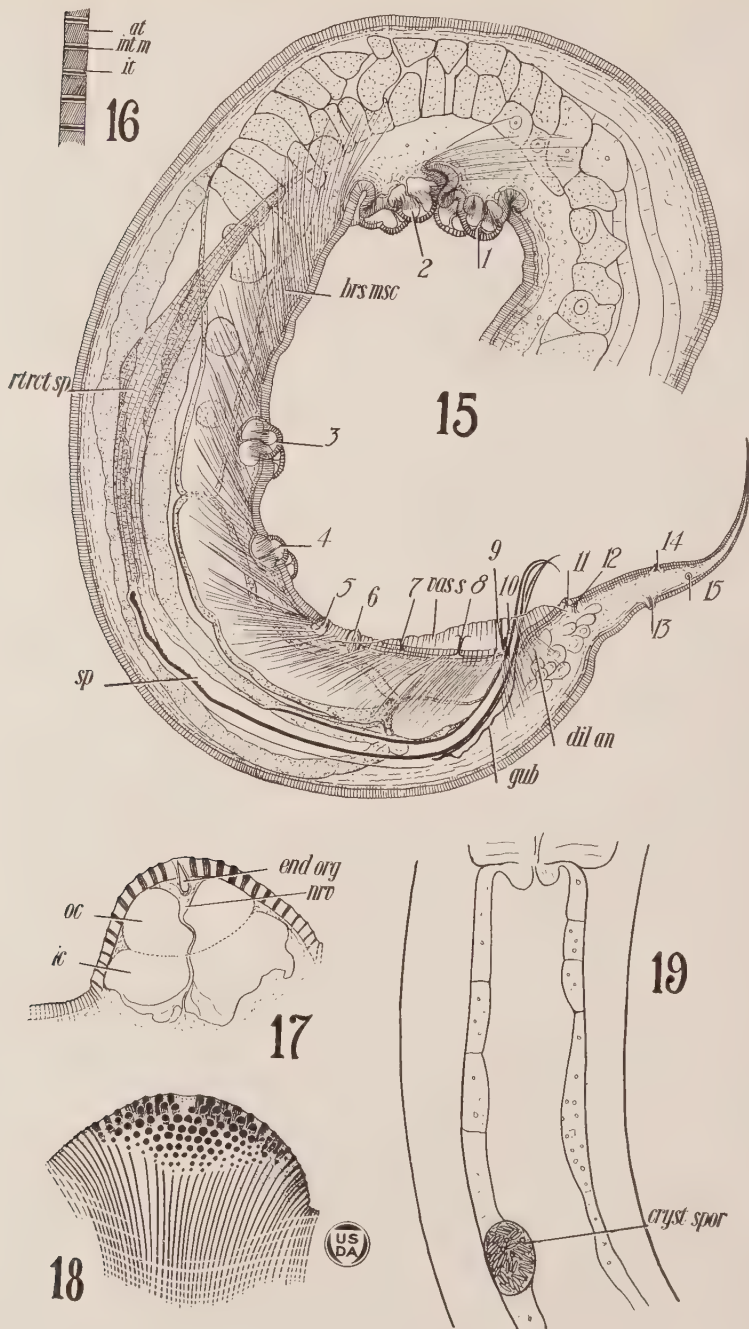


PLATE III

Cosmocercella haberi n.g. n.sp.

Fig. 15.—Tail end of male, lateral view; *brs msc*, bursal muscles; *dil an*, dilatator ani; *gub*, gubernaculum; *rtret sp*, retractor spiculi; *sp*, spiculum; *vas s*, vesiculated bursa; 1-4, plectanes; 5-6, papillae; 7-10, papillae within vesiculated bursa; 11-15, papillae of tail end.

Fig. 16.—Part of retractor spiculi; *at*, anisotropic part; *it*, isotropic part; *int m*, intermediate membrane within isotropic part.

Fig. 17.—Plectane in optical longitudinal section; *end org*, end organ; *ic*, inner chamber; *oc*, outer chamber; *nrv*, nervee.

Fig. 18.—Surface view of a plectane.

Fig. 19.—View of intestinal cell with parasites (coccidia) *cryst spor*.

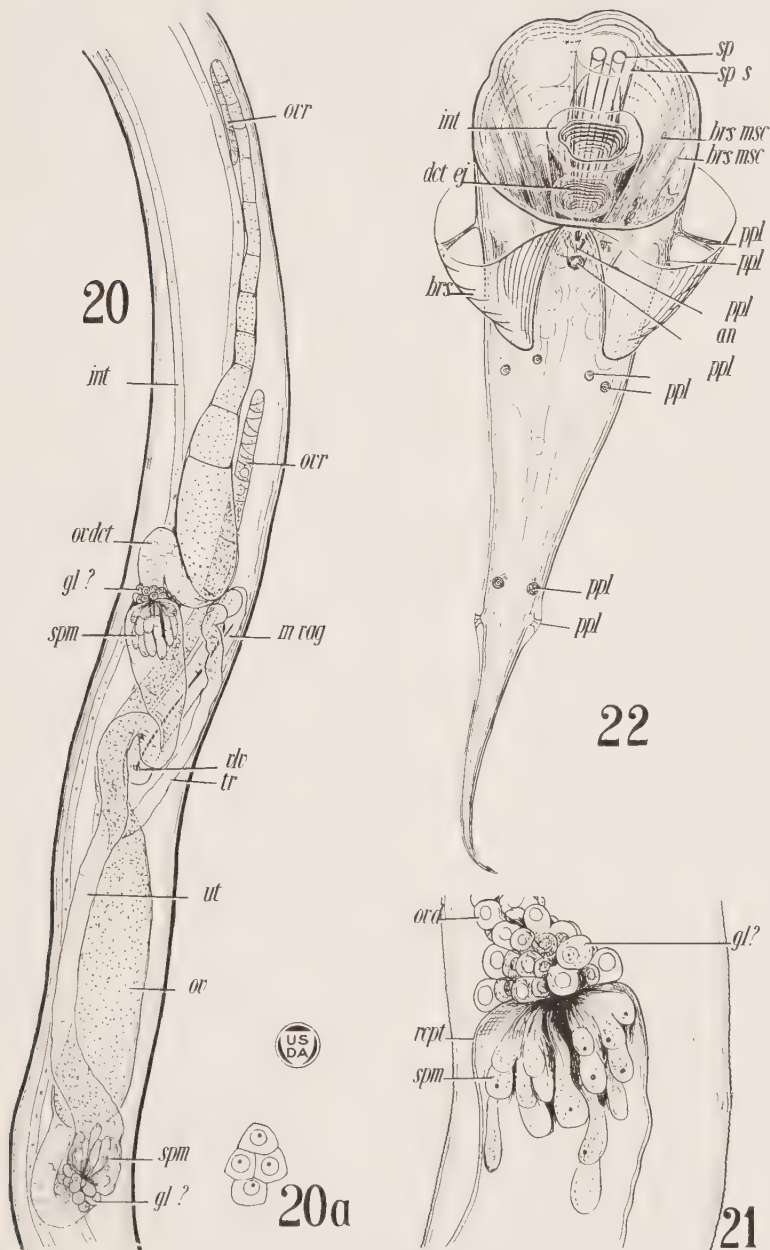


PLATE IV

Cosmocercella haberi n.g. n.sp.

Fig. 20.—Female sexual apparatus; *gl*?, probable glandular cells of oviduct; *int*, intestine; *ov*, egg; *ovdt*, oviduct; *ovr*, ovary; *spm*, spermatazoa within receptaculum seminis; *tr*, funnel; *ut*, uterus; *m vag*, vagina; *vlv*, vulva.

Fig. 20a.—Part of epithelium of oviduct.

Fig. 21.—Connecting part of oviduct and receptaculum seminis; *gl?*, probably glandular cells; *ovid*, oviduct; *rcpt*, receptaculum seminis; *spm*, spermatazoa.

Fig. 22.—Ventral view of male tail end; *an*, anus; *brs*, vesiculated bursa; *brs msc*, bursal muscles; *dct ej*, ejaculatory duct; *int*, intestine; *ppl*, papillae; *sp*, spiculum, *sp s*, sheath of spicula.

STEINER—NEMAS FROM CAROLINA TREE FROG

EXPLANATION OF PLATE V

Cosmocercella haberi n.g. n.sp.

Fig. 23.—Structure and organization of male gonad and outlet; *bod*, shiny globular bodies resembling polar bodies of female; *cla*, cloaca; *dct ej*, ejaculatory duct; *p sp*, pouch of spicula; *tst*, testis; *spm 1*, spermatocyte of first order; *spm 2*, spermatocyte of second order; *v def*, vas deferens; *vesic sem*, seminal vesicle.

Fig. 24.—Plectane as it first appears during ontogenesis.

Fig. 25.—Cross section through esophageal region of body.

Fig. 26.—Cross section through bulb of esophagus and valvular apparatus.

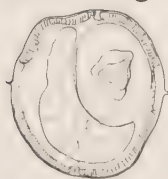
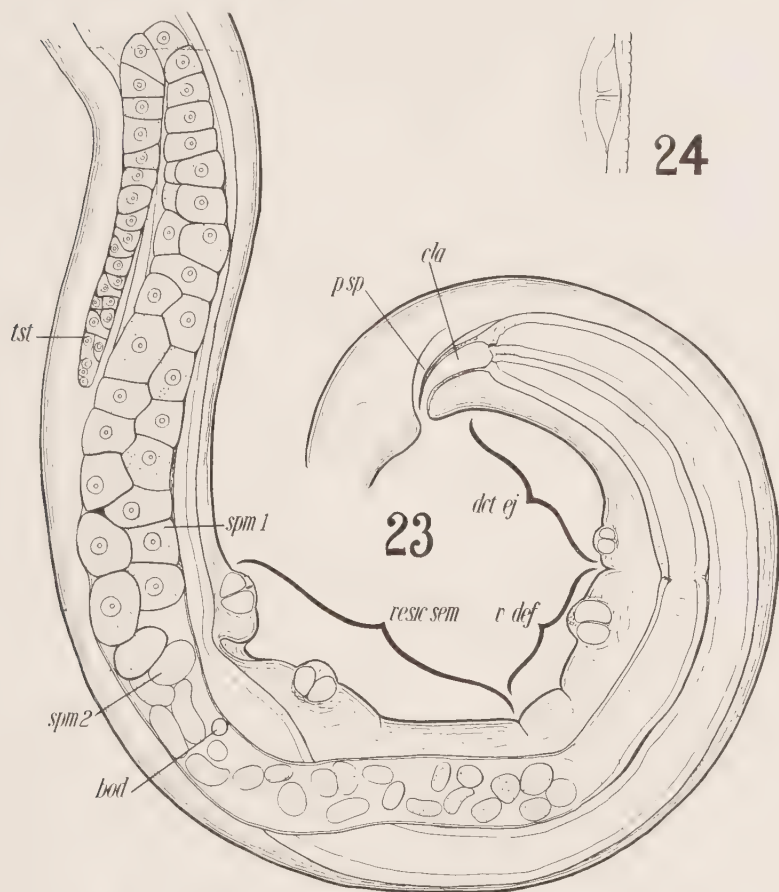
Fig. 27.—Cross section through cardiac region.

Fig. 28.—Cross section through middle of male.

Fig. 29.—Cross section through body behind cardia.

Fig. 30.—Cross section through proximal part of spicula and gubernaculum.

Fig. 31.—Cross section through body and distal part of spicula and gubernaculum.



STEINER—NEMAS FROM CAROLINA TREE FROG

EXPLANATION OF PLATE VI

Oswaldocruzia leidy Travassos

Fig. 32.—Anterior part of body; *an reg*, annulated region; *c p*, cervical papilla or deirid; *cut*, cutinized inner wall of intestine; *ex p*, excretory pore; *gl*, renette or ventral gland; *gng cl*, ganglion cells of nerve-ring; *int tis*, intermedian tissue layer in esophagus; *nrv r*, nerve-ring; *ves an reg*, vesiculated and annulated region.

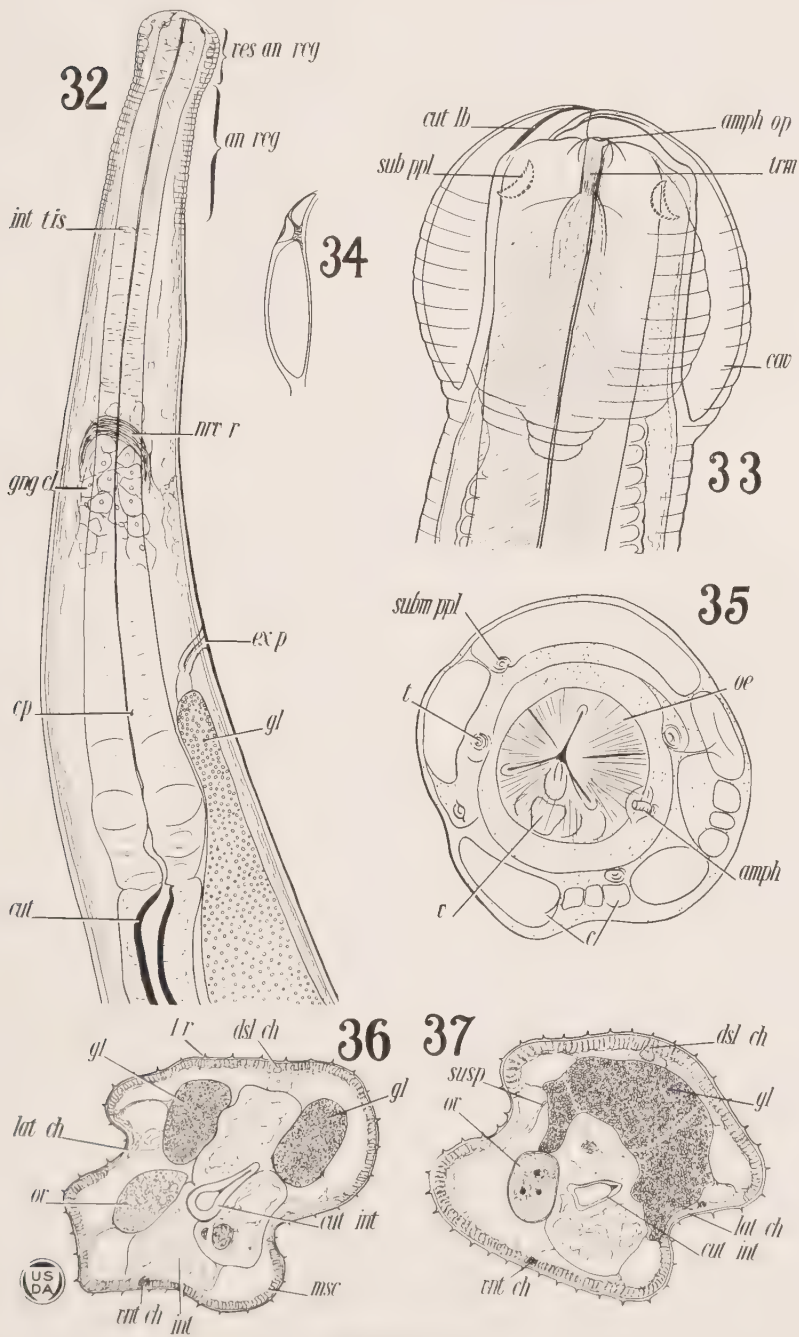
Fig. 33.—Lateral view of head end; *amph op*, opening of amphoid; *cav*, cavity of vesiculated region of head end; *cut lb*, cutinized inner wall of lips; *sub ppl*, submedian head papilla; *trm*, terminals.

Fig. 34.—Profile view of head papilla.

Fig. 35.—Front view of head; *amph*, amphid; *c*, cavity of vesiculated head region; *oe*, esophagus; *subm ppl*, submedian head papilla; *t*, terminals; *v*, possible glandular structure in ventral sector of esophagus.

Fig. 36.—Cross section some distance behind cardia, posterior to section in figure 37; *cut int*, cutinized wall of intestine; *dsl ch*, dorsal chord; *gl*, branch of ventral gland; *int*, intestine; *lat ch*, lateral chord; *l r*, longitudinal ribs on surface of cuticula; *msc*, muscles; *ov*, ovary; *vnt ch*, ventral chord.

Fig. 37.—Cross section behind cardia but in front of section in figure 36; *cut int*, cutinized inner wall of intestine; *dsl ch*, dorsal chord; *gl*, renette or ventral gland, middle lobe is separated from lateral branches; *lat ch*, lateral chord; *ov*, ovary; *susp*, suspensorium of ventral gland; *vnt ch*, ventral chord.



EXPLANATION OF PLATE VII

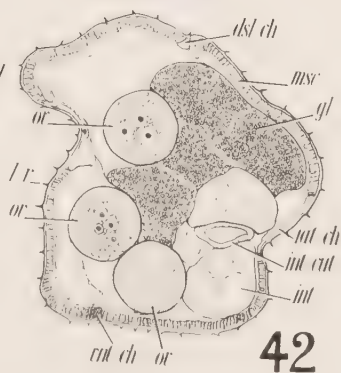
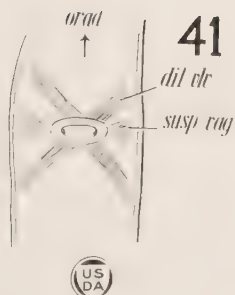
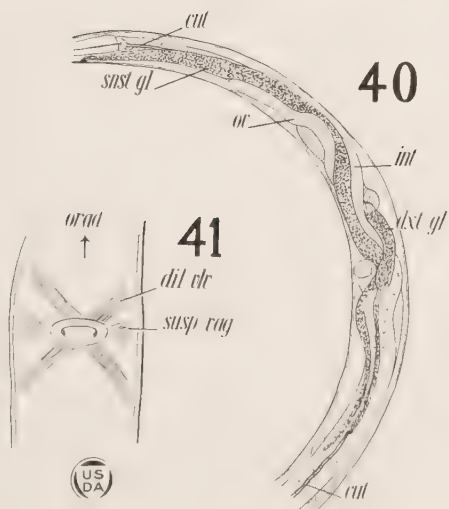
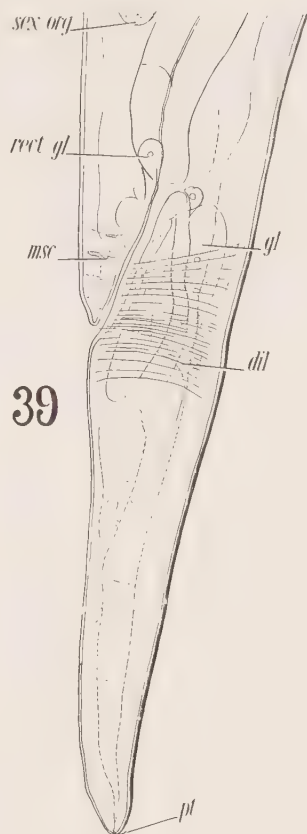
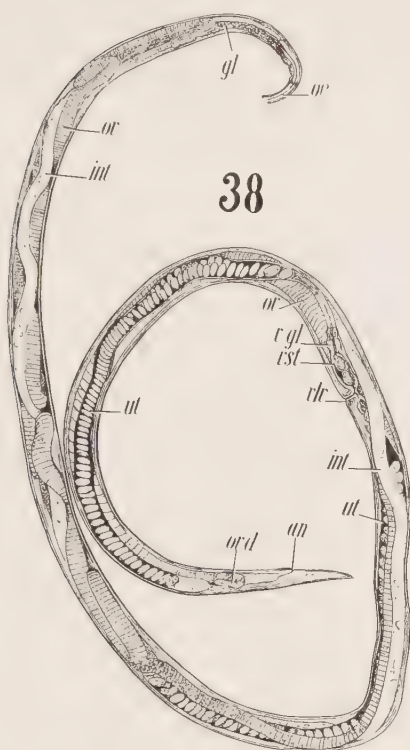
Fig. 38.—Total view of female; *an*, anus; *gl*, ventral gland or renette; *int*, intestine; *oc*, esophagus; *ov*, ovary; *ovd*, oviduct; *ut*, uterus; *v gl*, varnish gland of ovijector; *vlv*, vulva; *vst*, vestibule of ovijector.

Fig. 39.—Tail end of female; *dil an*, dilatator ani; *gl*, probably cell of caudal gland; *msc*, probably ventral dilatator muscles of rectum; *pt*, caudal terminal point; *rect gl*, rectal gland; *sex org*, ovary.

Fig. 40.—Excretory pore and ventral gland in lateral view; *cut*, cutinized inner wall of intestine; *dxt gl*, right branch of ventral gland; *ov*, ovary; *snst gl*, left branch of ventral gland.

Fig. 41.—Ventral view of vulva; *dil vlv*, dilatator vulva; *susp vag*, suspensory muscle of vagina.

Fig. 42.—Cross section between figures 36 and 37, still at level of middle lobe of ventral gland; *dsl ch*, dorsal chord; *gl*, ventral gland or renette; *inst*, intestine; *int cut*, cutinized inner wall of intestine; *lat ch*, lateral chord; *l r*, longitudinal ridge of surface of cuticula; *msc*, longitudinal muscles; *ov*, ovary; *vnt ch*, ventral chord.



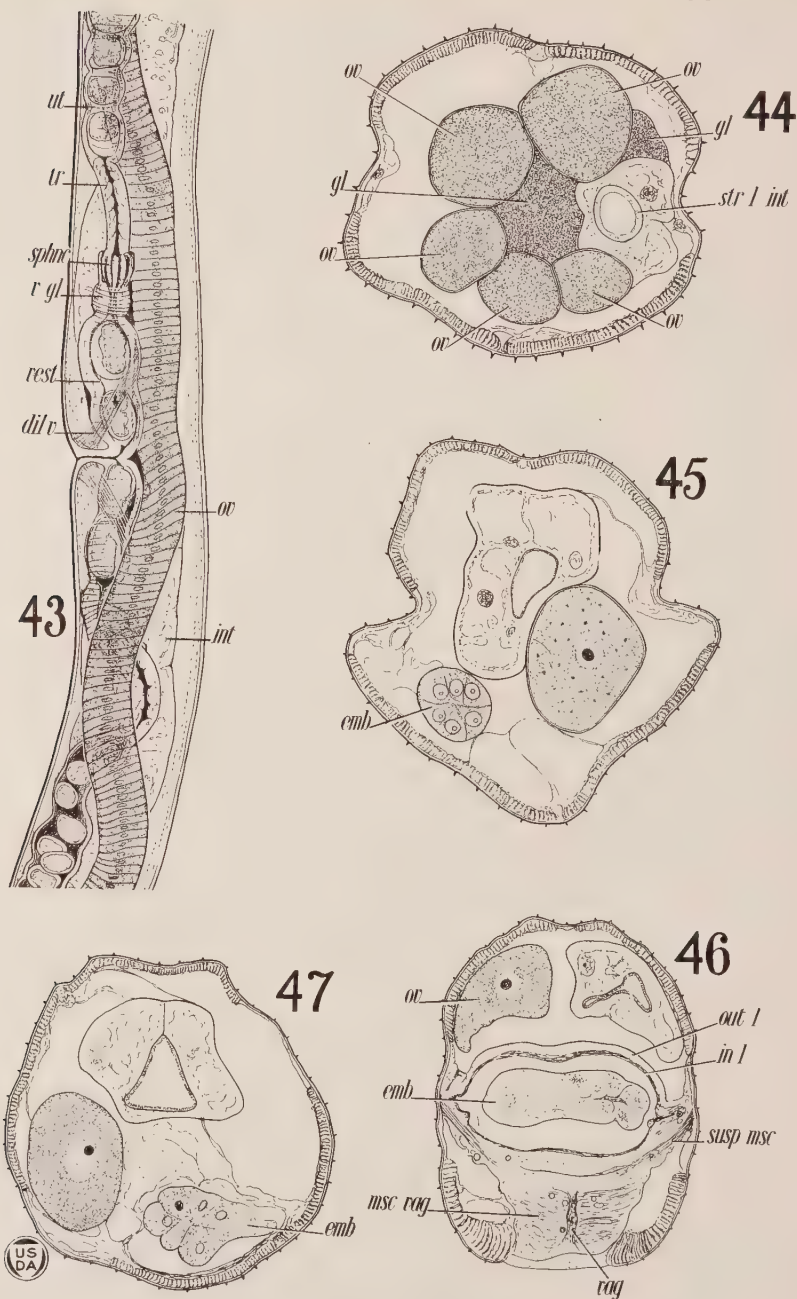


PLATE VIII

Oswaldocruzia leidy Travassos

Fig. 43.—Lateral view of vulvar region of female; *dil v*, dilated vulva; *int*, intestine; *ov*, ovary; *sphnc*, sphincter; *tr*, funnel; *ut*, uterus; *vest*, vestibule of ovijector; *v gl*, varnish gland.

Fig. 44.—Cross section through middle region near end of ventral gland; *gl*, ventral gland; *ov*, ovary; *str l int*, inner wall of intestine with radial fibers.

Fig. 45.—Cross section through anterior half, some distance in front of vulva; *em*, embryo.

Fig. 46.—Cross section through vulvar region; *susp msc*, suspensory muscle of vulva; *emb*, embryo; *in l*, inner layer of wall of vestibule; *msc vag*, muscles of vagina; *out l*, outer layer of wall of vestibule; *ov*, ovary; *vag*, vagina.

Fig. 47.—Cross section of posterior uterus region; *emb*, embryo.

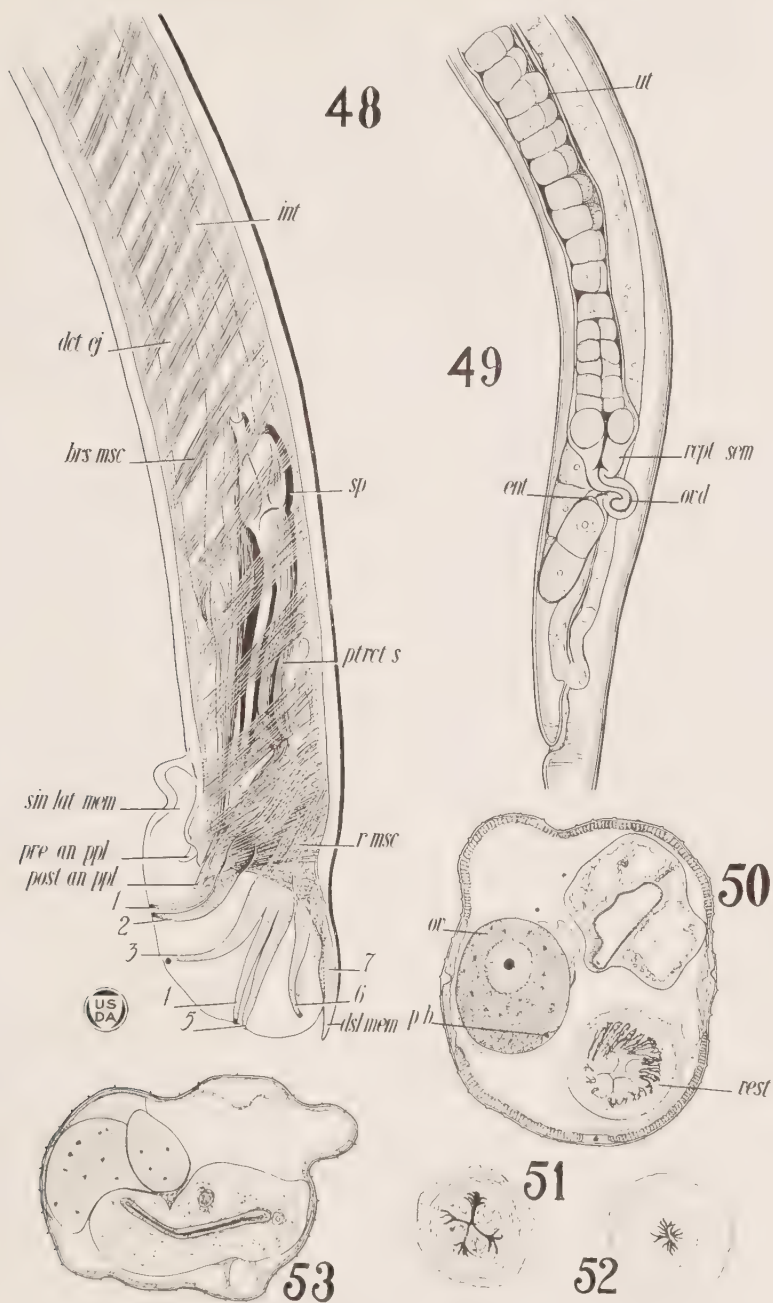


PLATE IX

Oswaldocruzia leidyi Travassos

Fig. 48.—Lateral view of tail end of male; *brs msc*, bursal muscles; *dct ej*, ejaculatory duct; *dsl mem*, dorsal lobe of the bursa; *int*, intestine; *post an ppl*, postanal papilla; *pre an ppl*, preanal papilla; *ptrct s*, protractor spiculi; *r msc*, muscles of bursa; *sin lat mem*, left bursal lobe; *sp*, spiculum; 1-7, the bursal ribs.

Fig. 49.—Uterus, oviduct and ovary of female; *ent*, entrance to oviduct; *ovd*, oviduct; *rcpt sem*, receptaculum seminis; *ut*, uterus.

Fig. 50.—Cross section through the region of vestibule of ovijector; *ov*, egg; *p b*, polar body; *vest*, vestibule.

Figs. 51 and 52.—Cross sections through sphincter.

Fig. 53.—Cross section through body near posterior loop of posterior ovary

STEINER—NEMAS FROM CAROLINA TREE FROG

EXPLANATION OF PLATE X

Ostwaldocrusia leidy Travassos

Fig. 54.—Dorsal view of male tail end; *dsl mem*, dorsal lobe of bursa; *rtrct*, retractor spicula; 7, rib of dorsal lobe of bursa.

Fig. 54a.—Ventral view of the excretory pore and the head region of the ventral gland; *c p*, cervical papilla or deirid; *dex br*, right branch of ventral gland; *md l*, median lobe of ventral gland; *ex p*, excretory pore; *sin br*, left branch of ventral gland; *vnt chr*, ventral chord.

Fig. 55.—Ventral view of male tail end; *dsl mem*, dorsal lobe of bursa.

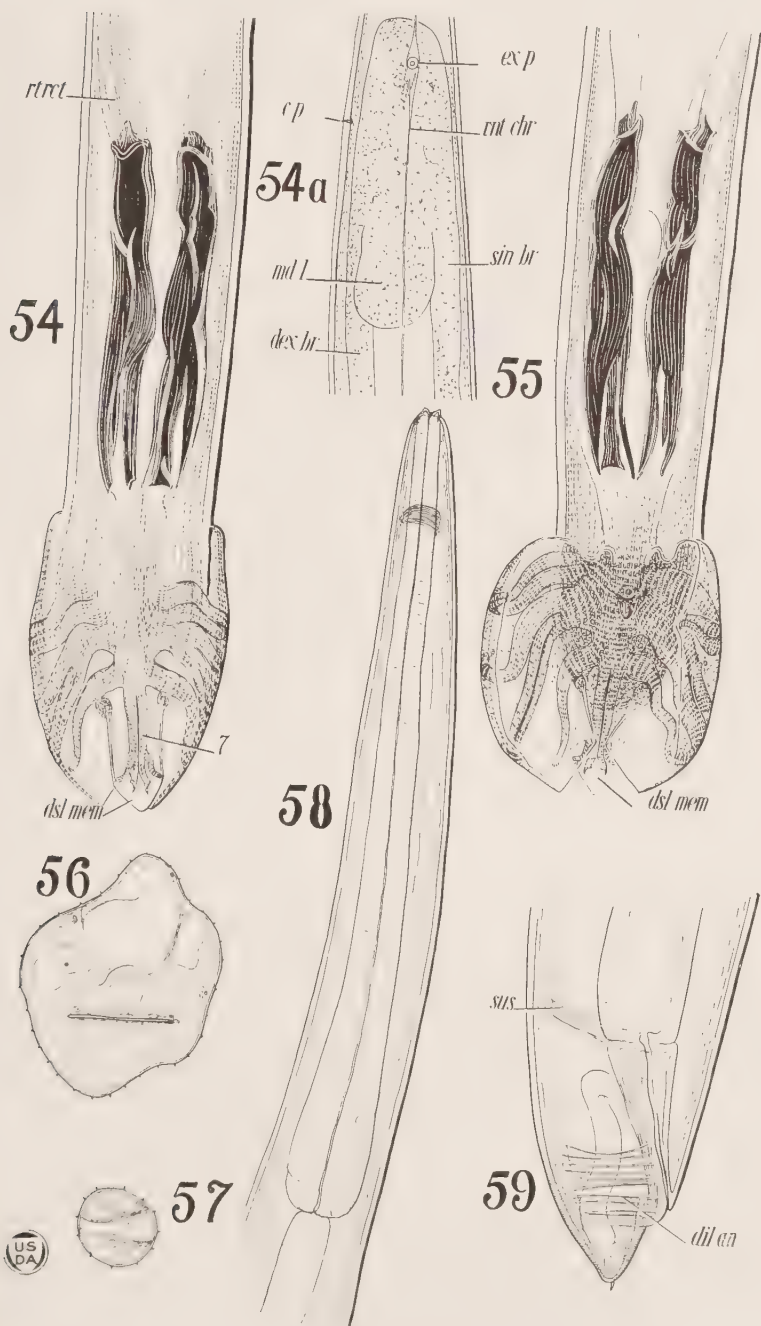
Fig. 56.—Cross section through rectal region.

Fig. 57.—Cross section through tail of female.

Agamascaris odontocephala n. sp.

Fig. 58.—Anterior end of larva.

Fig. 59.—Tail end of larva; *dil an*, dilatator ani; *sus*, suspensory muscle.



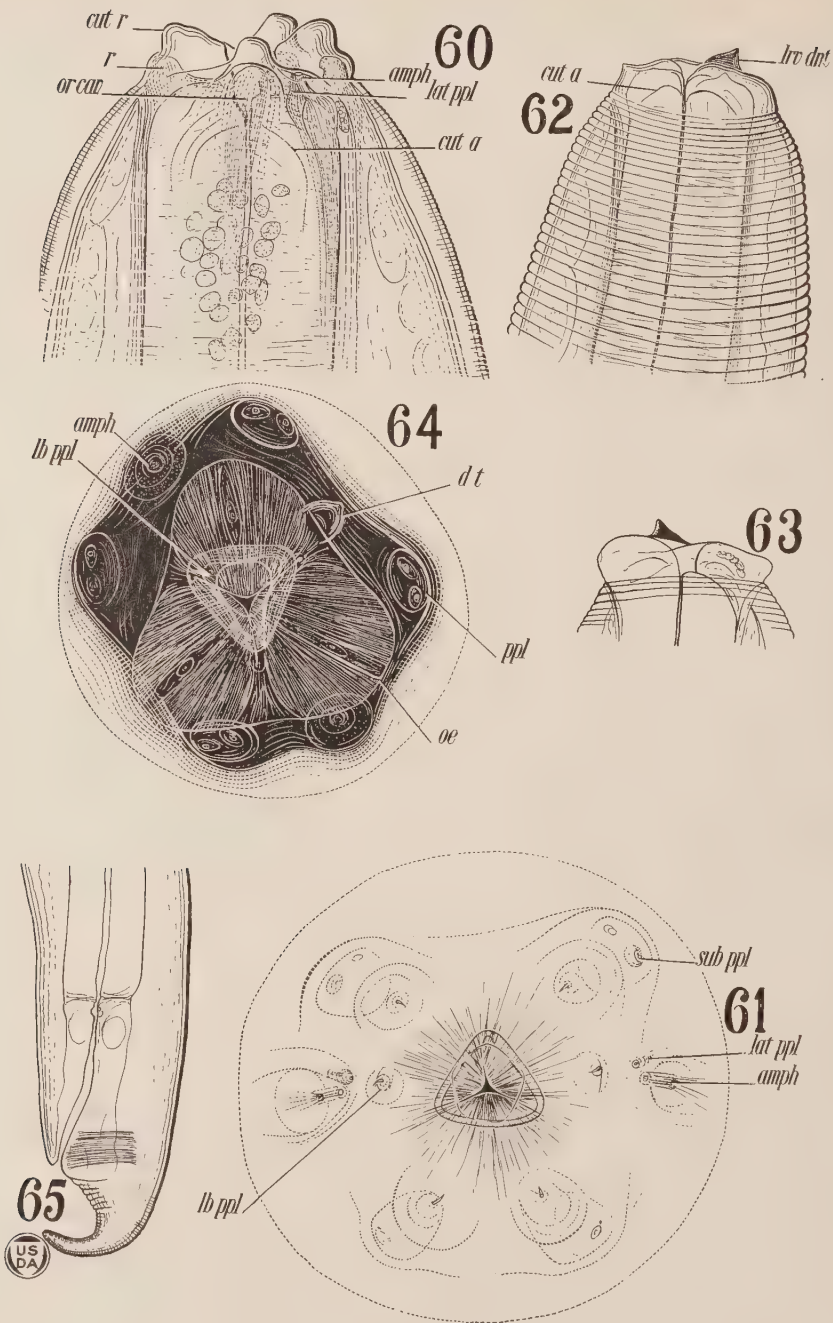


PLATE XI

Agamascaris odontoccephala n. sp.

Fig. 60.—Submedian view of head end; *amph*, amphid; *cut r*, cuticular tooth; *cut a*, cutinous stiffening bands of esophageal tissue around mouth cavity; *lat ppl*, lateral papilla; *or cav*, mouth cavity; *r*, probable remains of former head papilla.

Fig. 61.—Front view of head; *amph*, amphid; *lat ppl*, lateral papilla; *lb ppl*, labial papilla; *sub ppl*, probable remains of former submedian head papilla.

Agamascaris enopla n. sp.

Fig. 62.—Lateral view of head end; *cut a*, cutinous stiffening band of esophageal tissue around mouth cavity; *lrv dnt*, larval tooth.

Fig. 63.—Median view.

Fig. 64.—Same; front view of head; *amph*, amphid; *dt*, larval tooth; *lb ppl*, labial papilla; *oe*, esophagus; *ppl*, submedian head papilla.

Fig. 65.—Same; tail end.

HYMENOLEPIS MACRACANTHOS (v. LINSTOW)
CONSIDERATIONS SUR LE GENRE HYMENOLEPIS

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Nous avons trouvé dans un harle (*Mergus serrator*) tué sur le lac de Neuchâtel, un assez grand nombre d'un petit ténia qui semble être identique à *Hymenolepis macracanthos*, décrit par von Linstow (1877) d'après un seul exemplaire, n'ayant pas encore développé ses organes sexuels. Forme, nombre et grandeur des crochets correspondent assez bien avec la description et le dessin de l'auteur; il trouva cette espèce dans *Clangula clangula* Linn. Ce ténia présentant une anatomie intéressante nous en donnons une description détaillée.

Les plus grands exemplaires ont une longueur de 12 mm.; mais les derniers proglottis ne contenant pas d'oncosphères complètement développées, la taille maximale du vers est sans doute un peu plus grande; la largeur maximale est de 0.34 mm. Suivant l'état de contraction la forme générale du strobila peut varier beaucoup. La Figure 1 représente un strobila qui montre dans ses différentes régions des états de contraction qui peuvent se trouver sur des strobila entiers. Il ressort de là, que l'aspect extérieur du strobila est pour notre espèce, comme pour la plupart des cestodes, d'une valeur systématique douteuse si on ne peut pas indiquer l'état de contraction et de conservation de l'animal. Des individus fixés à l'état vivant au sublimé par exemple présenteront un strobila qui possède des proglottis de forme normale, tandis que des exemplaires qui sont morts dans l'intestin de l'hôte montreront le plus souvent des segments fortement allongés et ayant des aspects complètement différents.

Le scolex a un diamètre de 0.24 mm. et une longueur de 0.18 mm. Les deux paires de ventouses de forme ovale, souvent même vaguement triangulaires, sont très grandes, peu profondes et se touchent dans la ligne médiane. Leur longueur est de 0.14 mm., leur plus grande largeur qui peut se trouver, non au milieu mais vers l'extrémité postérieure, est de 0.12 mm. Le rostellum très long, mesure 0.2 mm. et se retire dans une poche très musculeuse qui est un peu plus longue que le scolex lui-même (0.22 mm.). Elle se prolonge de ce fait dans la région rétrécie (largeur 0.10 mm.) en arrière du scolex qu'on désigne habituellement comme cou, mais qui appartient peut-être encore au scolex parceque la zone proliférante, facilement visible par le fait qu'elle se colore beaucoup plus fortement avec le haemalun acétique, se trouve en arrière de l'extrémité distale de la poche du rostre.

Le scolex est armé de 8 grands crochets de forme très caractéristique, long de 0.128 mm. La forme ressemble beaucoup à celle de *H. gracilis*,

mais ils sont beaucoup plus grands, atteignant la taille de ceux de *H. liguloides* Gerv. et *H. rosenthali* Mola et dépassant légèrement la grandeur de ceux de *H. caroli* Par. et de *H. serrata* Fuhrmann (syn. *H. rugosus* Clerc.). La musculature et le système excréteur ne montre rien de particulier. Dans le parenchyme cortical se trouvent de nombreux petits corpuscules calcaires (0.009 mm.).

Les premières traces des organes sexuels se montrent dans le 15 à 20ième segment sous forme d'un très petit amas central de cellules se colorant vivement. Cet amas grandit lentement et dans le 50ième proglottis commence à s'ébaucher la poche du cirre en forme de massue, mais n'atteignant pas encore la cuticule. A partir de ce moment le développement de cet organe progresse rapidement, il s'en détache un petit amas, relié par une rangée de cellules à la poche du cirre. Ce n'est autre chose que l'ébauche de l'ovaire et de la glande vitellogène non différencié et du vagin encore confondu avec l'ébauche de la poche du cirre. L'ébauche des glandes femelles reste très longtemps stationnaire, tandis que les ébauches des trois testicules, qui semblent s'être détachés de la masse centrale, évolue avec la poche du cirre, rapidement. Déjà dans le 60ième proglottis environ, cette dernière traverse le proglottis dans toute sa largeur, dépassant même par places les vaisseaux excréteurs du côté antiporal. Dans le 82ième segment subitement les glandes sexuelles femelles évoluent très rapidement, elles formaient j'usqu'à maintenant un petit amas cellulaire. Les testicules par contre disparaissent (Fig. 6).

Ce n'est que dans 3 ou 4 segments que les glandes femelles se présentent en pleine maturité. Déjà dans le 90 à 92ième segment elles disparaissent à leur tour, pour être remplacées par l'utérus. Le développement des oncosphères se fait lentement puisque dans le 100ième segment, du plus grand exemplaire à notre disposition, les 6 crochets de l'oncosphère n'étaient pas encore développés.

Les organes sexuels mâles sont très caractéristiques par le fait du développement excessif de la poche du cirre qui dans certains proglottis ne dépasse pas seulement les vaisseaux excréteurs du côté opposé au pore sexuel, mais produit souvent sur le bord latéral du segment une protubérance et se trouve ainsi plus long que la largeur du segment (Fig. 4). La longueur de la poche du cirre est de 0.22-0.31 mm. avec un diamètre de 0.048 mm.; sa paroi musculeuse est très mince et lorsque le penis se dévagine elle se contracte relativement peu dans le sens de la longueur. Un rétracteur s'attache à la poche du cirre. Dans les jeunes proglottis où les testicules ne sont pas encore développés et où la vésicule séminale interne ne remplit pas encore la poche du cirre entière, on constate une grande quantité de grosses cellules entourant le canal déferant et ayant l'aspect de cellules glandulaires formant ainsi une zone prostatique très nette, semblable à celle des Distomes (Fig. 4).

Lorsque les vésicules séminales interne et externe sont bourrées de sperme, cette zone glandulaire a disparu, si bien qu'on peut se demander si ces cellules, dites prostatiques, piriformes et de structure glandulaire ne sont peut-être que des cellules parenchymateuses embryonnaires.

Le cirre présente une structure très spéciale qui s'observe également chez quelques Hymenolepis et qui a été déjà mentionné par plusieurs auteurs sans que ceux-ci aient fourni des dessins ou une explication pour ce type particulier d'organe copulateur. Le cirre, très gros, renflé à sa base (diamètre 0.018-0.036 mm.) à une longueur de 0.1 mm. Il est en outre recouvert de fines épines et montre complètement dévaginé un stylet qui mesure presque le double de la longueur du cirre (0.19 mm.) (Fig. 5b). A l'état de repos le stylet se trouve dans une longue gaine musculeuse, qui en se contractant, le dévagine (Fig. 5a, b). C'est sur du matériel frais que nous avons pu distinguer nettement cette disposition curieuse que nous avons retrouvé sur les coupes. Aucun Hymenolepis de Mammifères ne montre une disposition semblable, par contre nous trouvons chez les Oiseaux des espèces comme *H. venusta* Ross., *H. fragilis* (Krabbe), *H. serrata* Fuhrm., *H. flamingo* Skriabin, *H. macrocephala* Fuhrm., *H. tenuirostris* (Rud.) et d'autres encore des cirres avec stylet. Dans les proglottis à organes sexuels bien développés la vésicule séminale interne remplit toute la poche du cirre. La vésicule séminale externe, aussi grande que la poche du cirre et de forme semblable, passe sur le côté dorsal de celle-ci et dans la diagonale vers le bord postérieur du proglottis où se trouvent les trois testicules d'un diamètre de 0.07 à 0.08 mm. Ces derniers ne se trouvent pas sur une ligne, mais celui du bord opposé à l'ouverture sexuelle, est un peu déplacé en avant (Fig. 4).

Les glandes sexuelles femelles s'ébauchent, comme nous l'avons dit plus haut, sous forme d'un petit amas cellulaire qui augmente à peine tandis que les organes sexuels mâles évoluent rapidement et dans le 80ième proglottis encore on ne voit qu'un amas de forme ovale dans lequel, ovaire et glande vitellogène se trouvent réunis. Puis subitement le développement commence et deux ou trois segments plus loin les glandes femelles sont complètement mûrs. Encore trois ou quatre segments plus en arrière ces mêmes glandes ont complètement disparu et fait place à un utérus sacciforme.

L'ovaire est de forme très typique, puisqu'il présente toujours trois lobes, deux lobes antiporaux et un lobe poral. La glande vitellogène non lobée est large de 0.05 mm. La glande coquillière est dorsale. Le vagin montre une structure, ainsi qu'une position très spéciale. Il débouche en avant et du côté ventral de la poche du cirre, commençant par un large entonnoir tapissé d'une membrane cuticulaire plissée longitudinalement et entouré d'une mince couche de muscles surtout circulaires (Fig. 5a). Au fond de cet entonnoir se trouve une papilla à

canal très étroit et à paroi épaisse, elle est suivie d'un réceptacle séminal très volumineux qui s'étend du côté ventral sous la poche du cirre en arrière vers les glandes sexuelles femelles.

Lors de la copulation, le gros cirre s'introduit dans la partie porale très large, tandis que le stylet chitineux sans doute pénètre par l'ouverture étroite de la papille pour injecter le sperme dans le réceptacle séminal. Comme nous avons déjà dit plus haut les glandes femelles se développent et disparaissent très vite pour faire place à l'utérus sacciforme qui non seulement remplit le parenchyme interne mais dépasse, dans les proglottis entièrement mûrs les vaisseaux excréteurs s'étendant ainsi jusqu'à la cuticule. Les oncosphères n'étaient pas encore entièrement développés.

Notre espèce appartient au groupe des Hymenolepis à 8 crochets dont nous connaissons 21 espèces, habitant des Anseriformes (14), des Columbiformes (3), des Galliformes (1), des Lariformes (1), des Passiformes (1) et des Mammalia (1). Si nous considérons l'ensemble de ces formes nous constatons qu'à ce nombre égal de crochets ne correspond point une unité d'organisation. Déjà les crochets appartiennent à deux types différents, l'un sans levier antérieur et postérieur (*H. fasciculata* Rans. etc.) et l'autre avec levier antérieur bien développé comme *H. macrocephala* Fuhr. Entre ces deux types de crochets existent des formes de passage. Au point de vue anatomique nous trouvons des formes avec testicules disposés en une ligne transversale, d'autre avec le testicule antiporal nettement déplacé en avant. La poche dépasse chez certaines formes à peine le vaisseau excréteur poral, tandis que chez d'autres il atteint et dépasse même le vaisseau antiporal. (*H. macrocanthos* Linst). La poche du cirre peut même dans certains cas être contournée en spirale et de ce fait se trouve être plus longue que la largeur du proglottis (*H. fragilis*, Krabbe). Chez 5 espèces seulement on constate dans la poche du cirre un stylet chitineux semblable à celui que nous avons décrit pour *H. macracanthos*. Quelques espèces possèdent un sacculus accessorius (*H. bisaccata* Fuhrm. même deux), tandis que chez la plupart des espèces ce singulier appareil manque complètement.

La même constatation peut se faire pour les très nombreuses espèces à 10 crochets qui possèdent une beaucoup plus grande variété d'organisation encore dans la forme des crochets (Fuhmann, 1906; Fig. 1, pag. 625) et dans l'anatomie. Plus d'homogénéité existe pour les espèces qui portent plus de 10 crochets et qui se trouvent pour la plupart être des parasites de Mammifères. Les quelques formes vraiment dépourvues de crochets et ne possédant qu'un rostre rudimentaire ou point de rostre du tout, n'ont point non plus une grande ressemblance d'organisation. Nous arrivons donc à la même conclusion qu'en 1906 qu'il est impossible de subdiviser d'une manière naturelle ce très vaste

genre. Ceci d'autant plus que d'un assez grand nombre de formes, nous ne connaissons pas les crochets et d'un beaucoup plus grand nombre encore manquent des données anatomiques exactes. Le seul moyen pour faciliter la détermination de ces très nombreuses espèces serait de créer une classification artificielle de travail en groupant p. ex. les formes sans crochets (18 esp.) cells avec 8 crochets (21 esp.) cells avec 10 crochets (92 esp.) et celles avec plus de 10 crochets (39 esp.).

On peut maintenir comme sous-genre *Drepanidotaenia*, renfermant les espèces *H. lanceolata* (Goeze), *H. ardeae* Fuhrm. *H. bilateralis* v. Linstow, *H. elongata* Fuhrm., *H. setigera* (Frölich), *H. przewalskii* Skrjabin et *H. brachycephala* (Creplin). Ce sous-genre est surtout caractérisé par la position des glandes sexuelles femelles qui sont déplacés du côté antiporal, tandis que les testicules se trouvent du côté poral. Chez *H. lanceolata* à strobila très large, les glandes sexuelles se trouvent du côté aporal complètement en dehors des testicules, tandis que chez plusieurs espèces plus étroites, le testicule antiporal est placé en dessus de l'aile porale de l'ovaire. Chez *H. setigera* et *H. brachycephala* parcontre, les glandes femelles, surtout lorsqu'elles sont jeunes encore, se trouvent placées entre les deux testicules en question et en dessus de l'ovaire. Chez *H. clandestina* on remarque d'après Cohn une disposition semblable dans certains proglottis, mais dans la majorité des cas les testicules sont placés comme chez la plupart des *Hymenolepis*. Il n'y a donc pas une délimitation très nette de ce sous-genre.

En ce qui concerne le sous-genre *Echinocotyle* Blanch., il comprend : *Ech. rosseteri* (R. Blanch.), *Ech. nitida* (Krabbe), *Ech. nitidulans* (Krabbe), *Ech. uralensis* Clerc, et *Ech. multiglandularis* Bacz. Il s'ajoute à ces espèces 3 formes qui ne sont connu qu'à l'état larvaire, ce sont : *Ech. mrazeki* Daday, *Ech. polyacantha* Daday, et *Ech. linstowi* Daday ; cette dernière est peut-être identique avec *Ech. nitida* (Krabbe) (v. Daday, 1900).

Ce sous genre semble être bien caractérisé par la présence d'épines sur le ventouses, par une forme caractéristique des crochets, et la présence d'un *sacculus accessorius*. Mais il se trouve dans le vaste groupe des *Hymenolepis* des espèces, même avec *rostellum rudimentaire* dépourvu de crochets, manquant de *sacculus* (*H. carioca*) et qui ont les ventouses armées d'épines. D'autre part il existe des formes comme *H. collaris* (*H. sinuosa*) qui possèdent la forme spéciale des crochets du rostre et le *sacculus* des *Echinocotyle*, mais ont parcontre les ventouses inermes. Il est vrai que la larve de ce *taenia* présente des ventouses couvertes d'épines. C'est du reste une particularité de beaucoup de larves de *Hymenolepis* d'avoir les ventouses armées d'épines (v. Daday, 1900). *H. echinocotyle* Fuhr. et. *H. anatina*

(Krabbe) possèdent à l'état adulte les ventouses armées d'épines, seule ressemblance avec *Echinocotyle*. Il ressort de là que le sous-genre *Echinocotyle* n'est point non plus très nettement délimité.

Nous faisons suivre ces quelques considérations de la liste complète des espèces de *Hymenolepis* des oiseaux et des mammifères. Afin de faciliter quelque peu la détermination des nombreuses espèces nous indiquons pour chacune le nombre et la grandeur des crochets que porte le rostellum,* et nous classons les espèces habitant les différents groupes d'après le nombre de crochets et leur grandeur pour faciliter encore plus leur détermination.

Nous avons également jugé bon d'indiquer les pays de provenance des nombreuses espèces (206) de *Hymenolepis*, bien qu'il ne soit pas possible d'en tirer des considérations zoogéographiques, étant vu que nos connaissances faunistiques sont encore fort incomplètes pour tout les continents, à l'exception de l'Europe.

En effet la grande majorité des espèces connues (134) proviennent d'Europe (E.) et le reste se répartit en Asie (As.), Amérique du Nord et du Sud (Am. N., Am. S.), en Afrique (Af.), en Australie (Au.) et en Océanie (O.). Quelques rares formes ont été constatées dans la région antarctique (Ant.) Une demi douzaine d'espèces seulement sont cosmopolites (cosm.).

OISEAUX

CRYPTURIFORMES

H. pauciovata Fuhrm., 1906; cr. ?, Am. S.

GALLIFORMES

H. carioca (Magalhaes), 1898; cr. 0, cosm.

H. inermis Yoshida, 1910; cr. 0, As.

H. meleagris (Clerc), 1902; cr. 8, E.

H. lineæ (Goeze), 1782; cr. 10, 20-30 μ , E.

H. musculosa (Clerc), 1902; cr. 10, 30 μ , E.

H. phasiana Fuhrm., 1907; cr. 10, 38 μ , Af.

H. exigua Yoshida, 1910; cr. 10, 30-50 μ , As.

H. exilis (Dujardin), 1845; cr. ?, E.

H. microps (Diesing), 1850; cr. ?, E.

H. cantaniana (Polonio), [*H. oligophora*, Magal.] 1860; cr. ?, E., Am. N.

T. fedtschenkowi Solinow, 1911; [pour *H. villosa* (Bloch) des Gallinacées.]
cr. ?, E.

H. pullæ Cholod., 1913; cr. ?, E.

CHARADRIFORMES

H. glandularis Fuhrm., 1909; cr. o., Af.

H. spiculigera (Nitzsch) var. *varsowiensis* (Sinitzin), 1896; cr. 8-10, 30 μ , E.

H. recurvirostræ (Krabbe) 1869; cr. 10, 13-17 μ , E., Af.

H. (Echinocotyle) tenuis Clerc, 1906; cr. 10, 20 μ , E.

* Chez les espèces dont le scolex n'est pas connu, nous plaçons un point interrogatif.

- H. amphitricha* (Rud.), 1819; cr. 10, 21-23 μ , E., As.
H. interrupta (Rud.), 1809; cr. 10, 27 μ , E.
H. spinosa v. Linstow, 1906; cr. 10, 28 μ , As.
H. stylosoides Fuhrm., 1906; cr. 10, 30 μ , Af.
H. annandalei Southwell, 1922; cr. 10, 32 μ , As.
H. longirostris (Rud.), 1809; cr. 10, 33 μ , E.
H. vaginata Baczynska, 1914; cr. 10, 36 μ , Af.
H. uliginosa (Krabbe), 1882; cr. 10, 42-45 μ , E.
H. rectacanta Fuhrm., 1906; cr. 10, 45 μ , E.
H. clandestina (Krabbe), 1869; cr. 10, 47 μ , E.
H. brachycephala (Creplin), 1829; cr. 10, 50-57 μ , E.
H. (Echinocotyle) nitidulans (Krabbe), 1882; cr. 10, 54-57 μ , E.
H. (Echinocotyle) uralensis Clerc, 1902; cr. 10, 64-66 μ , E.
H. (Echinocotyle) nitida (Krabbe), 1869; cr. 10, 80-110 μ , E.
H. valleii (Stossich), 1892; cr. 10, E.
H. minor Ransom, 1909; nom. nov.; [syn. *H. minuta* (Krabbe), 1869.] cm. 14, 11-12 μ , E.
H. megalorhyncha (Krabbe), 1869; cr. 12-17, 70 μ , E.
H. sphaerophora (Rud.), 1809; cr. ?, E.
H. himantopodis (Krabbe), 1869; cr. ?, 8 μ , E. Af.

LARIFORMES *

* Krabbe, 1869, p. 289, indique comme hôte de *H. microsoma* (Creplin) également *Larus glaucus*, mais il s'agit sans doute d'une autre espèce; v. Fuhrmann, 1908, p. 8.

- H. octacanthoides* Fuhrm., 1906; cr. 8, ?, Af.
H. fusus (Krabbe), 1869; cr. 10, 15-17 μ , E.
H. chionis Fuhrm., 1921; cr. 10, 21-23 μ , Ant.
H. (Echinocotyle) multiglandularis Baczynska, 1914; cr. 10, 28 μ , E.
H. baschkienensis (Clerc), 1902; cr. ?, 73 μ , E.

COLUMBIFORMES

- H. obvelata* (Krabbe), 1879; cr. 8, 76 μ , As.
H. serrata Fuhrm., 1906; [syn., *H. rugosus* Clerc, 1906.] cr. 8, 102 μ , E., Af., As.
H. rosenstali Mola, 1913; cr. 8, 128 μ , E.
H. columbina Fuhrm., 1909; cr. 10, 16 μ , Af.
H. sphenoccephala (Rud.), 1809*; cr. ?, E.
H. armata Fuhrm., 1906; cr. ?, Am. S.

GRUIFORMES

- H. tubicirrosa* Baczynska, 1914; cr. ?, Am. S.

OTIDIFORMES

- H. ambiguus* Clerc, 1906; cr. 10, 30 μ , E.
H. villosa Bloch, 1782; cr. 14, 20 μ , E., As.
H. tetracis Cholod., 1906; cr. 16-20, 92-102 μ , E.

RALLIFORMES

- H. porzana* Fuhrm., n. sp.**; cr. 10, 38 μ , E.
H. poculifera (v. Linstow), 1879; cr. 10, 160 μ , E.

* D'après Railliet et Henry, 1909, cette espèce doit s'appeler *H. columbae* (Zeder). Nous ne pouvons admettre cette manière de voir, parceque nous ne savons à peu près rien sur ce taenia de Zeder, tandis que nous possédons les types de Rudolphi.

** Clerc (1911) a figuré des crochets d'un *H. sp.* qui doit être une nouvelle espèce que nous nommoe *H. porzana*.

PODICIPEDIFORMES

- H. capillaris* (Rud.), 1899; cr. 9, 10, 9-12 μ , E.
H. capillaroides Fuhrm., 1906; cr. 10, 21 μ , Am. S.
H. furcifera (Krabbe), 1869; cr. 10, 26-33 μ , E.
H. podicipina Syzanski, 1905; cr. 10, 42-46 μ , E.
H. multistriata (Rud.), 1809; cr. 10, 48-52 μ , E.
H. rostellata (Abildg.), 1793; [syn. *T. capitellata*, Rud., 1809.] cr. 10, 48-52 μ , E.

STEGANOPODES

- H. medici* (Stossich), 1890; cr. 22, 30 μ , E., Af.

CICONIIFORMES

- H. microcephala* (Rud.), 1819;* cr. 10, 13 μ , E., Af.
H. filirostris (Wedl.), 1856; cr. 10, 36-38 μ , E.
H. ardeae Fuhrm., 1906; [v. Ransom 1909 p. 72, note b.] cr. 10, 45 μ , Am. S.
H. elongata Fuhrm., 1906; cr. ?, Am. S.
H. breviannulata Fuhrm., 1906; cr. ?, Am. S.
H. ibidis Johnston, 1911; cr. ?, Au.

PHOENICOPTERI

- H. flamingo* Skrjabin, 1914; cr. 8, 62 μ , As.
H. megalorchis Lühe, 1898; cr. 8, 90 μ , Af.
H. caroli (Parona), 1887; cr. 8, 110-130 μ , E.
H. liguloides (Gervais), 1847; cr. 8, 130 μ , E., Af., As.

ANSERIFORMES

- H. megalops* (Nitzsch), (Creplin), 1829; cr. 0, cosm.
H. biaculata Fuhrm., 1909; cr. 0, Af.
H. lanceolata (Bloch), 1782; cr. 8, 31-35 μ , E.
H. octacantha (Krabbe), 1869; cr. 8, 32-40 μ , E.
H. bisaccata Fuhrm., 1906; cr. 8, 37 μ , Am. S.
H. venusta (Rosseter), 1897; cr. 8, 51-54 μ , E.
H. fragilis (Krabbe), 1869; cr. 8, 56-59 μ , E.
H. fasciculata Ransom, 1909; [syn. *T. fasciata* (Rud.)] cr. 8, 57 μ , E.
H. clausa v. Linstow, 1906; cr. 8, 57 μ , As.
H. macrocephala Fuhrm., 1913; cr. 8, 57-63 μ , E.
H. gracilis (Zeder), 1803; cr. 8, 76-82 μ , E.
H. macracanthos (v. Linstow), 1877; cr. 8, 108 μ , E.
H. kowalewski Bac., 1914; cr. 10, 10 μ , E.
H. parviceps (v. Linstow), 1872; ** cr. 10, 12 μ , E.
H. arcuata Kowal., 1905; cr. 10, 14-15 μ , E.
H. creplini (Krabbe), 1869; cr. 10, 21-22 μ , E.
H. tenuirostris (Rud.), 1819; cr. 10, 23-24 μ , E., As.
H. acquabilis (Rud.), 1809; cr. 10, 27-32 μ , E.
H. echinocotyle Fuhrm., 1907; cr. 10, 30 μ , E.
H. (Echinocotyle) rosseteri (Blanch.), 1891; cr. 10, 31-38 μ , E.
H. tritesticulata Fuhrm., 1907; cr. 10, 32 μ , E.
H. bilateralis v. Linstow, 1905; cr. 10, 33 μ , As.
H. voluta v. Linstow, 1904;*** cr. 10, 33 μ , E.

* *T. microcephala* Rud., 1819, et *H. leptoptili* (v. Linstow), 1901, sont d'après l'étude des originaux, synonyme de *H. multiformis* (Creplin), 1829.

*syn. *T. fasciata* (Rud.).

**décrit par v. Linstow, 1904, comme étant un *Diorchis*.

*** Syn. de *H. abortiva* v. Linstow, 1904, et *H. upsilon*, Rosseter, 1911.

- H. liophallos* (Krabbe), 1869; cr. 10, 35-38 μ , ? Au ?.
H. setigera (Frölich), 1789; cr. 10, 35-44 μ , E., As.
H. groenlandica (Krabbe), 1869; cr. 10, 38 μ , E.
H. parvula Kowal, 1905; cr. 10, 38-39 μ , E.
H. trichorhynchus Yoshida, 1910; cr. 10, 40 μ , As.
H. jaegerskiöldi Fuhrm., 1913; cr. 10, 42-45 μ , E.
H. pachycephala (v. Linstow), 1872; cr. 10, 44-49 μ , E.
H. orthacantha Fuhrm., 1906; cr. 10, 45 μ , Am. S.
H. microsoma (Creplin), 1829; cr. 10, 45-50 μ , E., As.
H. pigmentata (v. Linst.), 1872; cr. 10, 47 μ , E.
H. collaris (Batsch), 1786; cr. 10, 50-61 μ , cosm.
H. diorchis Fuhrm., 1913; cr. 10, 50-64 μ , E.
H. compressa (Linton), 1892; cr. 10, 55-59 μ , E., As. Am. N.
H. anatina (Krabbe), 1869; cr. 10, 65-72 μ , E.
H. tifolium v. Linstow, 1905; cr. 10, 67-70 μ , E.
H. tenerrima (v. Linstow), 1882; cr. 10 (9), 110 μ , E.
H. rarus Skrjabin, 1914; cr. 14, 103-105 μ , As.
H. teresoides Fuhrm., 1906; cr. 15, 90 μ , E.
H. querquedula Fuhrm., 1913; cr. 16, 14 μ , Am. S., Ant.
H. micrancristrota (Wedl), 1856; cr. 20, 10 μ , E.
H. simplex Fuhrm., 1906; cr. 20, 12 μ , E.
H. coronula (Dujardin), 1845; cr. 20-26, 14-19 μ , E.
H. megalhystera v. Linst., 1905; cr. 26, 18 μ , As.
H. fallax (Krabbe), 1869; cr. 28-30, 9-11 μ , E.
H. riggenbachi Mola, 1913; cr. 36-40, 23 μ (39 μ), E.
H. sagitta (Rosseter), 1906; cr. ?, 10 μ , E.
H. sibirica v. Linstow, 1905; cr. ?, As.
H. retracta v. Linstow, 1905; cr. ?, As.
H. papillata Fuhrm., 1906; cr. ?, Am. S.
H. flagellata Fuhrm., 1906; cr. ?, Am. S.
H. lobata Fuhrm., 1906; cr. ?, Am. S.
H. longicirrosa Fuhrm., 1906; cr. ?, As.
H. longivaginata Fuhrm., 1906; cr. ?, E.
H. conscripta (Raill. et Henry), 1909; [syn. *T. Krabbei*, Kowal.] cr. ?, E.
H. terraereginae Johnston, 1911; cr. ?, Au.
H. villosoides Solowiow, 1911; cr. ?, E.
H. solowiowi Skrjabin, 1914; cr. ?, As.
H. przewalski Skrjabin, 1914; cr. ?, As.

CORACIIFORMES

- H. parvirostellata* (v. Linstow), 1901; cr. 8, 13 μ , Af.
H. brasiliensis Fuhrm., 1906; cr. 10, 30 μ , Am. S.
H. septaria v. Linstow, 1906; cr. ?, As.
H. caprimulgorum Fuhrm., 1906; cr. ?, Am. S.

COCCYGIFORMES

- H. hassalli* Fuhrm.,* nov. nom.; cr. 10, 19 μ , O.
H. intermedius Clerc, 1906; cr. 10, 22-25 μ , E.

PICI

- H. crenata* (Goeze), 1782, (Kostylev. 1915); cr. 10, 23 μ , E.

*Le nom de *H. asymetrica* ayant déjà été employé pour un Hymenolepis de Mammifères, nous changerons ce nom en *H. hassalli*.

PASSERIFORMES

- H. bilharzii* (Krabbe), 1869; cr. 10, 16 μ , Af.
H. polygramma (v. Linstow), 1875; cr. 10, 17 μ , E.
H. petrocinclae (Krabbe), 1882; cr. 10, 18 μ , As.
H. hemignathi Shipley, 1898; cr. 10, 18-23 μ , O.
H. globocephala Fuhrm., 1918; cr. 10, 19 μ , O.
H. clerci Fuhrm., 1923; * cr. 10, 20 μ , E.
H. passerina Fuhrm., 1907; cr. 10, 20 μ , Af.
H. farciminosa (Goeze), 1782; cr. 10, 20-23 μ , E.
H. microscolecina Fuhrm., 1906; cr. 10, 23 μ , Am. S.
H. serpentulus (Schrank), 1788; cr. 10, 24-27, 19-21 μ , E., Af., Au.
H. fringillarum (Rud.), 1809; cr. 10, 26-28 μ , E.
H. stylosa (Rud.), 1809; cr. 10, 28-32 μ , E., As., Af.
H. magniovata Fuhrm., 1918; cr. 10, 30 μ , O.
H. zosteropsis Fuhrm., 1918; cr. 10, 30-32 μ , O.
H. pellucida Fuhrm., 1906; cr. 10, 32-34 μ , Am. S.
H. dahurica (v. Linstow), 1903; cr. 10, 34 μ , As.
H. brevicirrosa Fuhrm., 1912; cr. 10, 36 μ , O.
H. brevis Fuhrm., 1906; cr. 10, 40 μ , E.
H. naja (Dujardin), 1845; cr. 10, 52 μ , E.
H. parina Fuhrm., 1907; cr. 10, 60 μ , E.
H. orientalis (Krabbe), 1882; cr. 10, 90 μ , As.
H. tichodroma Fuhrm., 1908; cr. 11, E.
H. importata Fuhrm., 1918; cr. 12-14, 12-16 μ , O.
H. acridotheridis (Par.), 1890; cr. 16?, 75 μ , As.

MAMMIFÈRES

MARSUPIALIA

- H. peramelidarum* Nybelin, 1917; cr. 44-46, 100 μ , Au.

RODENTIA

- H. diminuta* (Rud.), 1819; cr. 0, cosm.
H. myoxi (Rud.), 1819; cr. 0, E.
H. relicta (Zschokke), 1887; cr. 0, E.
H. megaloon Linstow, 1901; cr. 0, As.
H. horrida Linstow, 1900; cr. 0, E.
H. procera Janicki, 1904; cr. 0, E.
H. diminutoides Cholod., 1912; cr. 0, E.
H. arvicolina Cholod., 1912; cr. 0, E.
H. octocoronata (v. Linstow), 1879; cr. 8, 62 μ , Am. S.
H. evaginata Barker & Andrews, 1915; cr. 10, 7 μ , Am. N.
H. inexpectata Cholod., 1912; cr. 20, 17 μ , E.
H. macroscelidarum Baer, 1924; cr. 20, 17 μ , Afr.
H. muris-variegati Janicki, 1904; cr. 20, 105 μ , Af.
H. longior Baylis, 1922; cr. 21-22, 19-20 μ , E.
H. fraterna Stiles, 1906; cr. 22-24, 18-24 μ , E.
H. criceti Janicki, 1904; cr. 24, 16 μ , E.
H. contracta Janicki, 1904; cr. 28, E.
H. microstoma (Dujardin), 1845; cr. 30, 11 μ , E.
H. straminea (Goeze), 1782; cr. ?, 14 μ , E., As.
H. crassa Janicki, 1904; cr. ?, E.
H. asymetrica Janicki, 1904; cr. ?, E.
H. sciurina Cholod., 1912; cr. ?, E.

* syn. *H. interruptus* Clerc, 1906; ce nom étant déjà employé par Rudolphi pour un *Taenia* qui rentre également dans le genre *Hymenolepis*.

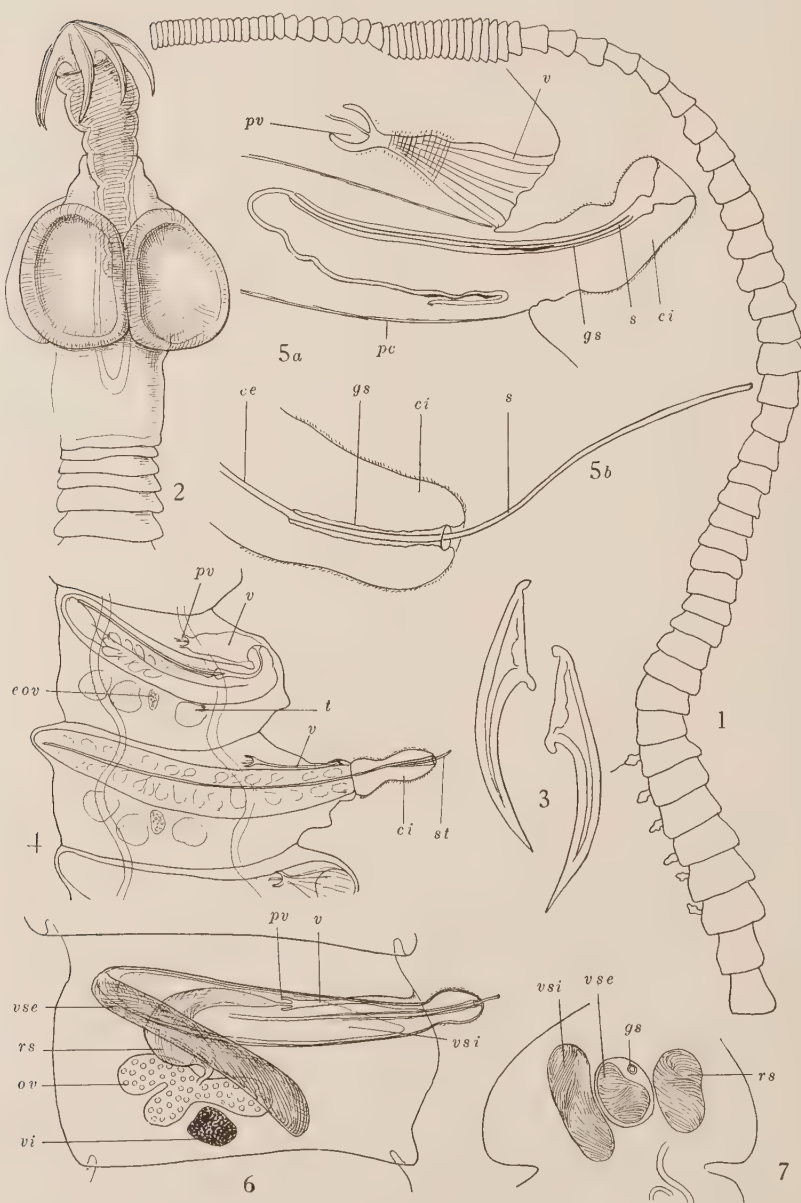


PLATE XII

INSECTIVORA

- H. diaphana* Cholod., 1906; cr. 0, E.
H. steudeneri Janicki, 1904; cr. 0, E.
H. jacobsoni v. Linstow, 1907; cr. 10, 21 μ , As.
H. singularis Cholod., 1912; cr. 10, E.
H. scalaris (Dujardin), 1845; cr. 12-13, 26-33 μ , E.
H. uncinata (Stieda), 1862; cr. 14-20, 17-20 μ , E.
H. chrysochloridis Janicki, 1904; cr. 16-18, 29 μ , Af.
H. spinulosa Cholod., 1906; cr. 18-20, 34 μ , As.
H. erinacei (Gmelin), 1790; cr. 20, 17 μ , E.
H. pistillum (Duj.), 1845; cr. 20, 10 μ , E.
H. furcata (Stieda), 1862; cr. 22-28, 24 μ , E.
H. tiara (Duj.), 1845; cr. 30-34, 22-26 μ , E.
H. bacillaris (Goeze), 1782; cr. 36, 20 μ , E.
H. barroisii (Moniez), 1880; cr. ?, E.
H. capensis Janicki, 1904; cr. ?, Af.

CHIROPTERA

- H. moniezii* Par., 1893; cr. 0, As
H. acuta (Rud.), 1819; cr. 38-42, 39 μ , E.
H. decipiens (Dies.), 1850; cr. 40-46, 23 μ , Am. S.

PRIMATES

- H. cebidarum* Baer, 1924; cr. 0., Am. S.

HOMO

- H. diminuta* (Rud.), 1819; cr. 0, cosm.
H. nana (v. Siebold), 1853; cr. 22-27, 16-20 μ , cosm.

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EXPLANATION OF PLATE XII

Fig. 1.—Strobila dessiné à la chambre claire.

Fig. 2.—Scolex.

Fig. 3.—Crochets.

Fig. 4.—Proglottis jeunes (préparation totale): *ci*, cirre; *s*, stylet; *t*, testicule; *v*, vagin; *pv*, papille du vagin; *eov*, ébauche de l'ovaire et de la glande vitellogène.

Fig. 5.—Organe copulateur: *pc*, poche du cirre; *ci*, cirre; *s*, stylet; *gs*, gaine du stylet; *ce*, canal éjaculateur; *v*, vagin; *pv*, papille du vagin.

Fig. 6.—Proglottis femelle (préparation totale): *visi*, vésicule séminale interne; *vse*, vésicule séminale externe; *pv*, papille du vagin; *rs*, réceptacle séminal; *ov*, ovaire; *vi*, glande vitellogène.

Fig. 7.—Coupe oblique d'un proglottis: *visi*, vésicule séminale interne; *vse*, vésicule séminale externe; *gs*, gaine du stylet; *rs*, réceptacle séminal.

OPHIOTAENIA TESTUDO, A NEW SPECIES FROM
AMYDA SPINIFERA*

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While examining soft-shelled turtles of the species *Amyda spinifera* during the summer of 1921, a cestode was found in the intestines belonging to the genus *Ophiotaenia*, but differing from all other members of the genus heretofore described. *Ophiotaenia testudo* is proposed for the name of this tapeworm. The find is believed to be unique in that there is in American literature no description of a cestode from a turtle. Indeed the reference to Cestoda from these reptiles are rare in foreign literature.

Stiles and Hassall (1894) list a *Taenia* sp. from *Trionyx* sp. but do not give a description of it. From *Testudo mydas* Rudolphi (1819) described *Tetrarhynchus macrobothrius*. Leuckart (1879) records a species of *Tetrarhynchus* from *Tethys fimbriata*, and *Bothriocephalus imbricatus* and *Tetrarhynchobothrium bicolor* are known from *Hali-chelys atra*. Lönnberg (1894) described in somewhat general terms a cestode from *Trionyx ferox* taken in Florida, which he called *Tetrabothrium trionychinum*. The only definite facts that can be obtained from his description are that the longest strobilias were from 3 to 4 cm. and that their greatest breadth was 1 mm. The scolex was distinct, club-shaped and 0.5 mm. in diameter. There were four rounded suckers, but no rostellum. The number of oval testes was very great and they occupied the middle of the proglottid. The cirrus sac was large and thin-walled, opening near the anterior end of the segment. The genital pores alternated irregularly on the two sides. The vagina opened anterior to the penis. The ovaries were large, the vitellaria peripheral and follicular. From this meager general description it is impossible positively to identify any worm found today as the form Lönnberg described. However, from his general discussion he was probably dealing with a member of the genus *Ophiotaenia*, and since he obtained the cestode from a soft-shelled turtle from Florida, it is possible though not likely that the species was the same as that I am describing, *Ophiotaenia testudo*. Lönnberg's species escaped the notice of LaRue, who does not include it in his masterful monograph on *Proteocephalidae*; however it is listed by Rudin (1917).

* Contribution from the Laboratory of the United States Bureau of Fisheries, Fairport, Iowa, and the Mayo Clinic, Rochester, Minn.

Twenty specimens of *Amyda spinifera* from the Mississippi River at Lake City, Minnesota, were examined. Thirteen, all of those whose carapaces were more than 8 inches long, were infected with from one to ten worms; the others were not infected. This may be explained on the basis of age, which would determine to some extent the type of food that they are able to obtain, or by the fact that the larger turtles eat more than the smaller ones, thus having more chances to become infected. The food of the soft-shelled turtles differs somewhat from that of the hard-shelled ones; the former eat a great many crayfish, while the latter usually do not, if ever, eat these crustaceans. This suggested the possibility that the crayfish might act as the intermediate host for the parasite since no hard-shelled turtles examined from this region have been infected with this cestode. Many crayfish were examined from the region of Lake City, but no parasites were found. Several crayfish were fed the ova of the cestode, and others were kept in aquaria with macerated segments of the tapeworm, but nothing developed to indicate that the larval stage lives in the crayfish. Further experiments are outlined for the study of the life history of this cestode, but at present no clue can be offered.

DESCRIPTION OF THE SPECIES *Ophiotaenia testudo*

The species belongs to the family Proteocephalidae described by La Rue. The head is small, the suckers are sessile and without accessory areola. The fifth sucker, if present, is functional and vestigial. There is no rostellum. The genital organs in general are like those in other tetraphylideans; the genital pores are marginal, and irregularly alternating; the vitellaria are lateral with follicles closely grouped about a central conducting tubule; the ovary situated posteriorly is bilobed and the shell gland is oöcapt, oötype, with a uterine passage. The uterus has lateral outpocketings and one or more preformed ventral uterine openings; the vitellaria, testes, ovary and uterus are within the inner longitudinal muscle-sheath. The habitat of this family is in fresh-water fishes, amphibia, and aquatic reptiles.

The genus *Ophiotaenia* La Rue (1911) has the following characteristics: The characters of the family, a globose or somewhat tetragonal head, and no rostellum, hooks nor spines. The suckers are circular or oval, with margins entire, the fifth sucker being vestigial. The neck is usually long. The testes are in two long lateral fields anterior to the ovary. The vagina is anterior or posterior to the cirrus-pouch. The ovary is bilobed, flattened, and sometimes alate. The parenchyma is fine meshed, the musculature weak. Its habitat is in aquatic snakes: Crotalinae, Colubridae, Elapinae and amphibia. This habitat should be extended to include the soft-shelled turtles.

Ophiotaenia testudo is small and slender, the strobila measuring from 30 to 50 cm. in length, and not more than 1.6 mm. in width. The segmentation is quite distinct and the head easily recognized since it is set off sharply from the rest of the worm. The head is small, globose in shape, slightly flattened anteriorly, 0.42 mm. long and 0.63 mm. in diameter. The four powerful suckers are circular and prominent, 0.12 mm. by 0.10 mm. The fifth sucker is lacking, there being but a very slight apical depression, no rostellum and no spines, and in sections there is no evidence of a vestigial fifth sucker. The neck is rather narrow and long, in well preserved specimens being 6 mm. long and 0.24 mm. wide. The breadth of the first proglottids is greater than length, but the length becomes greater than the breadth as they mature; the largest ones are 2.1 mm. long and 1.6 mm. wide. The musculature is on the whole weak, and the parenchyma coarse, filled probably with fat and glycogen. The genital organs are typical of the genus. There is no genital papilla. The genital pore is irregularly alternating and marginal, being situated at the juncture of the anterior and second sixths. By means of the genital pore the small genital atrium is connected with the exterior; into the latter both the vagina and cirrus open. The vagina always lies anterior to the cirrus pouch. The testes, from 125 to 200 in number, are more or less spherical or ovoid, and are about 0.05 mm. by 0.063 mm. They are in the two broad lateral fields extending to the free median zone, and lie dorsal to the uterus. The vas deferens forms a rather large mass of many coils just back of the cirrus sac. This region must also act as a vesicula seminalis for it appears swollen with the mass of ripening spermatozoa. The mass of coils extends to the middle line, where the more or less convoluted vas deferens has proceeded anteriorly, somewhat dorsal to the vagina. The vas deferens is made up of collecting tubules from the testes, its origin occurring shortly after they reach the middle line. The vas deferens after entering the cirrus pouch, makes many coils forming the ductus ejaculatorius before passing into the more or less curved and weak muscled cirrus, which when protruded is about 0.65 mm. in length. It is slender, but somewhat attenuated towards its tip. The cirrus pouch is 0.56 mm. long and 0.27 mm. in diameter at its widest point. It is broadest at its inner end, and is somewhat pear-shaped.

The female reproductive organs are characteristic of the genus, but present certain specific peculiarities. The vitellaria lie in two fields almost the entire length of the segments, and in the lateral margins inside the longitudinal muscles. The follicles tend to be grouped more or less around the collecting tubules, of which there is a right and left one. These paired ducts pass towards the middle line and unite anterior to the oviduct to form the unpaired vitelline duct. Sometimes a com-

missure unites the paired ducts dorsal to the oviduct. The common duct enters the oötype near its middle portion and not the "oviduct just before the latter enters the oötype" which is the rule according to La Rue. In a personal communication La Rue stated that this variation could be expected, and I believe that it in no way invalidates his general description. The vagina, opening in the genital atrum in common with the cirrus to which it is both anterior and dorsal, passes anterior to the cirrus pouch, never crossing it, and reaches the middle line after making several loose turns. The terminal portion of the vagina is surrounded by a rather well developed vaginal sphincter. The tube, after reaching the middle line, passes posteriorly and dorsal to the uterus as a narrow wavy thin-walled tube. Just after the longitudinal tube enters the inter-ovarian space it broadens out somewhat, forming a receptaculum seminis. There is some tendency for the lower vagina to be looped in the inter-ovarian space, but below the receptaculum it is narrowed and muscular, entering the oviduct about at its juncture with the middle and terminal thirds.

The ovaries are made up of loose tubules so arranged that they form two lobes more or less alate in shape. The ovaries extend only in the middle half of the posterior end of the proglottid. Ventrally they practically cover the interovarian space, and from the ventral posterior margin in the middle line the oviduct arises. First as the oöcapt, a funnel-shaped muscular organ, the oviduct with a rather thick wall, proceeds posteriorly and dorsally, forming a loop in a plane at right angles to the longitudinal plane, and receives the vagina as described. Beginning at this point the tube is known as the fertilization passage, and it discharges into the oötype. This short muscular tube, which is not perfectly straight, is surrounded by many gland cells, each of which is slender and discharges into the oötype through its own duct; this group of cells is called the shell gland. The oötype discharges into the uterine passage which leads anteriorly, after making a few coils, and enters the medial stem of the uterus slightly anterior to its posterior margin. In fully developed proglottids, the uterus occupies the ventral middle portion, extending well anterior to the cirrus sac, and posteriorly to the level below the anterior margin of the ovaries. It has from fifteen to twenty lateral pouches. Its ventral openings were not accurately enumerated.

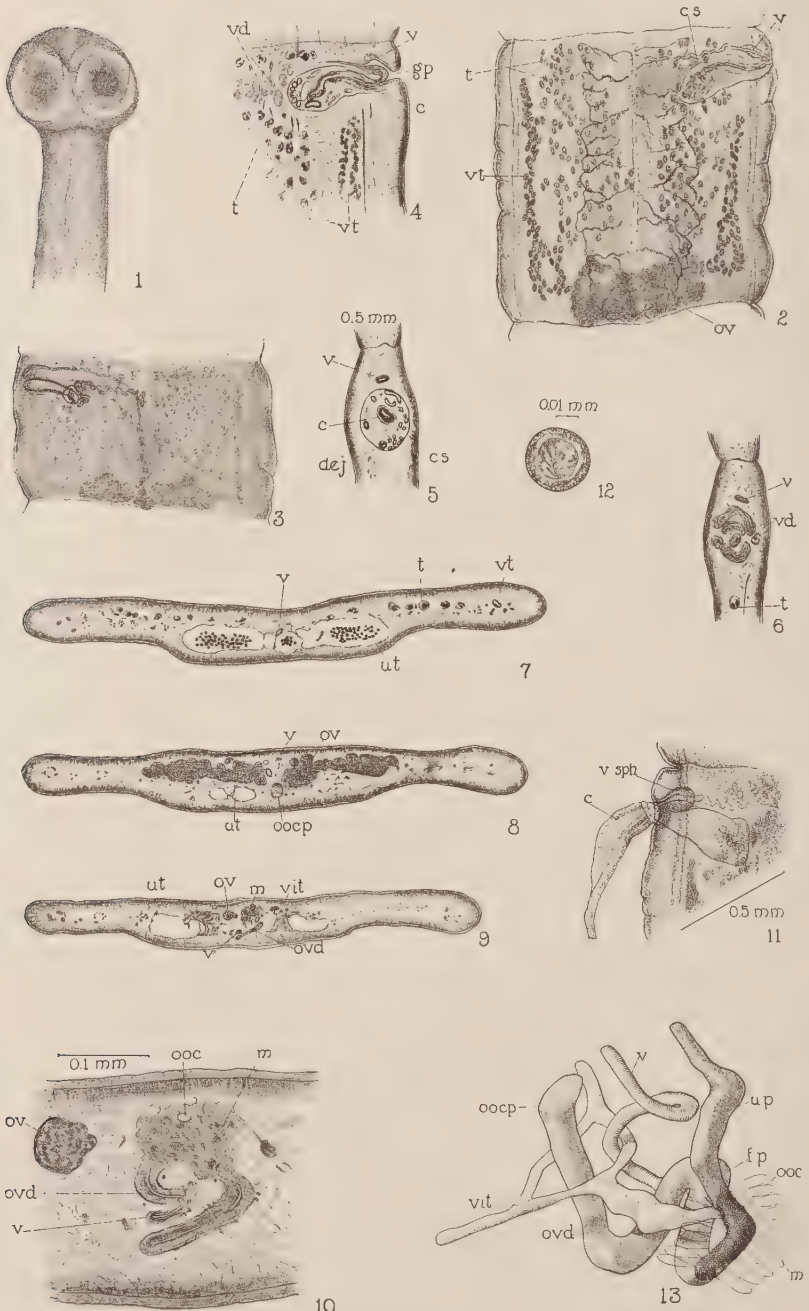
The eggs, typical of the genus, have three membranes, the outer one being smooth and averaging 0.029 mm. in diameter. The embryo is six hooked and is from 0.019 to 0.021 mm. in diameter.

The table shows *Ophiotaenia testudo* compared in major details with its nearest relatives, *Ophiotaenia filaroides*, *Ophiotaenia perspicua* and *Ophiotaenia grandis*.

Comparison of Selected Characters of Species of Ophiotaenia

Characters	Ophiotaenia filarioides La Rue	Ophiotaenia perspicua La Rue	Ophiotaenia grandis La Rue	Ophiotaenia testudo Magath
Strobila.....	8.0 to 11.0 cm. by 0.8 to 0.9 mm. at widest part	36 cm. by 2.0 mm. at widest part..	Fragments 2.75 to 4.25 mm. at widest part and 30 cm. long	30 to 50 cm. by 1.6 mm. at widest part
Neck.....	3 to 4 mm. long, narrow.....	5 to 7 mm. by 0.17 to 0.425 mm.	4 to 8 mm. by 0.85 to 1.0 mm.	6.3 mm. by 0.24 mm.
First proglottids.....	0.1 to 0.17 mm. by 0.3 to 0.36 mm.	Much broader than long.....	Much broader than long.....	Broader than long
Mature proglottids....	Quadrate or longer than broad...	2 mm. square or longer than broad	Usually longer than broad.....	Longer than broad
Ripe proglottids.....	1.6 by 0.8 mm. to 4.0 by 0.75 mm.	Largest proglottid 3.8 by 1.2 mm..	Usually longer than broad; 3 to 5 mm. by 2 to 3 mm.; longest segment 8 by 2.75 mm.	2.1 by 1.6 mm.
Head.....	Globose, flattened dorsoventrally, apex conical 0.396 to 0.46 mm. broad	Conical, flattened dorsoventrally, cut by deep grooves, 0.355 to 0.408 mm. broad	Somewhat conical, base swollen and merged with neck, 1 to 1.2 mm. by 0.5 to 0.6 mm.	Globose, slightly flattened anteriorly; 0.42 by 0.63 mm.
Suckers (the four)....	Oval with deep cavity; maximum dimensions 0.165 to 0.184 mm.	Circular, oval or somewhat triangular; maximum dimension 0.105 to 0.17 mm.	Circular, not prominent, 0.35 to 0.36 by 0.34 to 0.35 mm.	Circular, prominent, 0.12 by 0.10 mm.
Fifth sucker.....	Vestigial, deep set in tissues of head	Vestigial, deep set in tissues of head	Not present; vestigial.....	Not present
Genital pore, location on margin of segment	At end of first fifth of proglottid	At end of first third to half.....	Near middle	At end of anterior 1/4
Cirrus-pouch, length into breadth of segment	0.22 by 0.11 mm.	0.255 to 0.32 by 0.08 to 0.09 mm. ..	0.64 to 0.75 by 0.24 to 0.26 mm.	0.56 mm. by 0.27 mm.
	3 to 4 times.....	3 to 4 times.....	3 to 5 times.....	3 to 4 times
Ductus ejaculatorius..	With few coils.....	In several coils.....	Nearly straight	In many coils
Testes, number.....	70 to 114.....	150 to 215.....	200 to 250.....	125 to 200
Testes, size.....	0.05 to 0.06 mm. in diameter.....	0.053 to 0.106 mm. in diameter...	0.04 to 0.05 by 0.075 to 0.125 mm...	0.050 by 0.063 mm.
Testes, arrangement...	In 2 lateral fields.....	In 2 lateral fields.....	In 2 broad lateral fields.....	In 2 lateral fields
Vagina, relation of, to cirrus-pouch	Anterior to cirrus-pouch, never crossing latter	Anterior or posterior to cirrus-pouch, never crossing latter	Anterior or posterior to cirrus-pouch	Anterior to cirrus-pouch, never crossing
Uterus, pouches on either side	20 to 35.....	20 to 30.....	40 to 60.....	15 to 25
Embryo, size.....	Diameter 0.21 mm.	0.018 to 0.021 mm. in diameter.....	0.015 to 0.016 mm. in diameter....	0.019 to 0.021 mm. in diameter
Eggs, number and size of membranes	Three membranes, outer one 0.035 to 0.1 mm., second 0.03 mm. in diameter	Three membranes, outer one 0.045 to 0.1 mm. in diameter	Three membranes, outer one 0.085 mm., second 0.028 to 0.03 mm. in diameter	Three membranes, outer one 0.029 mm., middle one 0.024 mm.
Hosts.....	Amblystoma tigrinum	Natrix rhombifer	Ancistronodon piscivorus	Amyda spinifera

MAGATH—NEW OPHIOTAENIA FROM TURTLE



SUMMARY

A new species of *Ophiotaenia*, *Ophiotaenia testudo* is described. It was obtained from *Amyda spinifera* from Lake City, Minnesota.

It is the first cestode from the turtle described in American literature.

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EXPLANATION OF PLATE XIII

1. Head of *Ophiotaenia testudo*.
 2. Mature segment.
 3. Immature segment.
 4. Frontal section through genital pore.
 5. Sagittal section through cirrus sac.
 6. Sagittal section just medial to cirrus sac.
 7. Transverse section through mature segment, anterior to ovary.
 8. Transverse section through level of oöcapt.
 9. Transverse section through shell gland.
 10. Transverse section showing entrance of vagina into oviduct.
 11. Extended cirrus drawn from live specimen.
 12. Ovum.
 13. Drawing from wax reconstruction of female genital organs.
- Figs. 1 to 9 inclusive, are drawn to the scale shown in Figure 5.

Abbreviations

<i>c</i> cirrus	<i>ovd</i> oviduct
<i>cs</i> cirrus sac	<i>t</i> testes
<i>dej</i> ductus ejaculatorius	<i>up</i> uterine passage
<i>fp</i> fertilization passage	<i>ut</i> uterus
<i>gp</i> genital pore	<i>v</i> vagina
<i>m</i> shell gland	<i>vd</i> vas deferens
<i>ooc</i> oöcyst	<i>v sph</i> vaginal sphincter
<i>oocp</i> oöcapt	<i>vit</i> vitteline duct
<i>ov</i> ovary	<i>vit</i> vittellaria

NOTES ON *ORNITHOBILHARZIA ODHNERI* N. SP.
FROM THE ASIATIC CURLEW *

ERNEST CARROLL FAUST

In examining specimens of the Asiatic curlew, *Numenius arquatus*, at Peking in the fall of the year for various helminth parasites, certain specimens taken from the portal veins proved to be blood-flukes of an undescribed species. A study of the worms recovered from the examinations indicates that they belong to the genus *Ornithobilharzia*, established by Odhner in 1912. The new species is designated *Ornithobilharzia odhneri* in honor of Professor Odhner.

In all, eight curlews were examined at the migratory season in the fall, and from them were secured fifteen blood-flukes. In seven of these birds only one specimen each, a mature male, was found. In the eighth, two females, and a pair of copula were obtained. Ten individuals of the same species of host, on their northern journey in the spring, contained no infection.

DESCRIPTION OF *Ornithobilharzia odhneri*

Ornithobilharzia odhneri has furnished data which not only makes it possible to place it in the genus *Ornithobilharzia* but which add materially to the amount of information concerning the details of structure in this group. The female is a delicate worm measuring about 3.0 mm. in length by 0.1 to 0.12 mm. in cross section. The oral sucker and the acetabulum average 70 μ each in diameter. The entire integument is provided with fine spines. The gut bifurcates just anterior to the acetabulum and remains double for about four-fifths the body distance distad, where two furci unite to form a single cecum which ends blindly in the sub-distal region of the body. The ceca are only moderately serpentine and have no commissures such as Odhner (1912:63) has designated as characteristic for the genus from his study of the species *O. intermedia*. The region of the gut from the oral sucker to the bifurcation is surrounded by esophageal glands.

The female genital organs require detailed consideration in view of the fact that Odhner's description is incomplete, probably due to poorly preserved material, since the worms are delicate and lose their detail of organization very soon after the death of the host. There is a loosely coiled elongate ovary (Fig. 2, *ov*) in the proximal third of the body.

* From the Parasitology Laboratory, Peking Union Medical College, and from the Department of Medical Zoology, School of Hygiene and Public Health, Johns Hopkins University. Read before the section of parasitology, American Society of Zoologists, Dec. 28, 1923.

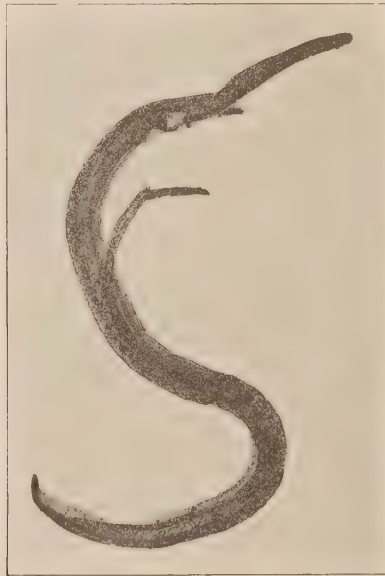
The oviduct arises from the posterior extremity of the ovary, bending laterad and continuing anteriad to the ootype (*oo*). Just behind the ovary is a well-organized seminal receptacle, which in the living worm contains motile spermatozoa. There is a short duct connecting the seminal receptacle with the proximal region of the oviduct (Fig. 3). In this respect it differs from Odhner's *Gigantobilharzia acotylea* (1910, Fig. 5) in which the seminal receptacle is shown as an enlargement rather than an outpocketing of the oviduct. Arising from the dorsal aspect of the seminal receptacle is a duct which can be no other than Laurer's canal (Fig. 3, *lc*). Not only is the duct present, but it opens through a minute pore to the dorsal surface of the worm. The paired vitelline follicles occupy a large portion of the body from the post-receptacular position to the sub-distal region. The vitelline duct (*vd*) can be traced forward to the ootype. The ootype is easily recognized not only by the fact that it is the common terminus of the oviduct and the common vitelline duct, but by the group of Mehlis' glands which surround it. The uterus (*u*) is short and uncoiled, bending sharply ventrad to open at the genital pore (*gp*) which occupies a median position just behind the acetabulum. I have found only a single egg (*o*) in the uterus. As nearly as I can determine it appears to be rounded at one end and pointed at the other, but on account of its collapsed condition accurate measurement was not possible.

The male worm of *Ornithobilharzia odhneri* measures from 6 to 7 mm. in length by 0.22 to 0.26 mm. in cross section. The oral sucker has a diameter of 120 to 155 μ and the ventral sucker, 160 to 165 μ . The integument is spinose. The gut is similar to that of the female. The gynecophoral canal is deep and broad. The oval testes (*t*) lie mesad in the middle three-sevenths of the body. They number about 65. The vas deferens (*va*) runs forward from the anteriormost member of the series to the seminal vesicle (*sv*), which lies midway between the testes and the acetabulum. This organ communicates directly with the rudimentary cirrus sac which lies dorsal to the genital pore. The ejaculatory duct is rudimentary while prostate glands are lacking.

There is no definite clue to the life-history of this species of avian schistosome, but it seems altogether likely that the worm follows the same general course of development as that of the mammalian schistosome species.

A study of the structure of *Ornithobilharzia odhneri* in comparison with the other described schistosome species indicates that it is most closely related to those species which Odhner (1912), has grouped under the genus *Ornithobilharzia*. The previously described species consist of *O. intermedia* Odhner 1912 (designated as type); *O. canaliculata*

(Rudolphi 1819), and *O. kowalewskii* (Parona e Ariola 1896). Very little detailed information exists regarding the latter two, while that of the female worm in *O. intermedia* is by no means complete. In the light of the data obtained from the study of *Ornithobilharzia odhneri*, the generic description of Odhner is both incomplete and non-generic (See table). In other words, it fits only the species *O. intermedia*, which was the only form about which detailed information was at that time available. For this reason the generic description requires amendment to include the species herein described.



Text Fig. 1.—Photograph of male and female *Ornithobilharzia odhneri* in copula. $\times 20$.

GENUS *Ornithobilharzia* Odhner 1912 (emend.)

In the male: testicular follicles from 65 to 110 in described species; seminal vesicle communicating directly with the ejaculatory duct or separated by a non-muscular canal.

In the female: ovary elongate, either loosely coiled or tightly twisted; seminal receptacle with Laurer's canal, present; genital pore immediately behind acetabulum.

The presence of a Laurer's canal in this group is of considerable significance in the phylogenetic relations of the schistosomes. In the mammalian species the seminal receptacle is lacking. In *Gigantobilharzia acotylea*, the only avian species in which the details of structure

have been heretofore carefully studied, a well-developed seminal receptacle is present but there is no indication either in the text or illustrations (Odhner 1910: 384-385, figs. 4-5), of a Laurer's canal. It may be stated with considerable certainty, therefore, that the generative organs in *Ornithobilharzia odhneri* represent a type much less modified in these respects than are these organs in *Gigantobilharzia* and the mammalian schistosomes. In fact, it seems altogether likely that Laurer's canal in this species may actually function at times for the reception of sperm

Comparative Data on Ornithobilharzia intermedia and O. odhneri.

	Ornithobilharzia intermedia Odhner	O. odhneri n. sp.
♀ Length × width.....	4.5-5.75 × 0.17-0.22 mm.	3.0 × 0.1-0.12 mm.
Oral sucker.....	0.04-0.05 mm.	0.07
Acetabulum.....	0.025-0.035 mm.	0.07
Gut.....	As in male	As in male
Ovary.....	Long, tightly twisted	Long, loosely coiled
Seminal receptacle.....	Present
Vitelline follicles.....	In 2 series from ovary to posterior end	In 2 series from ovary to posterior end
Mehlis' gland.....	Present
Laurer's canal.....	Present, opening dorsad
Genital pore.....	Opening just below acetabulum
Eggs.....	Ca. 70 × 50 μ (one only)	(One only)
Integument.....	Finely spinose	Finely spinose
♂ Length × width.....	8-10.6 × 0.42 mm.	6.0-7.0 × 0.22:26
Oral sucker.....	0.2-0.25 mm.	0.120-0.155 mm.
Acetabulum.....	0.3-0.35 mm.	0.160-0.175 mm.
Gut.....	Anastomosing behind posterior testes	Uniting only once behind posterior testes
Testes.....	90-110, from acetabulum through middle third of body	About 65, through middle half of body
Seminal vesicle.....	United to ejaculatory duct by short epithelial canal	Directly joined to ejaculatory duct
Cirrus sac.....	Rudimentary	Rudimentary
Ejaculatory duct.....	Present	Rudimentary
Prostate gland.....	Lacking	Lacking
Genital pore.....	Small, half way to left side	Small, some distance behind acetabulum
Integument.....	Spinose	Spinose

directly from the male ejaculatory organ. If this is the case, the long debated theoretical function of this organ actually has a means of solution.

SUMMARY

1. A new species of avian schistosome, designated as *Ornithobilharzia odhneri*, is described from the curlew, *Numenius arquatus*.

2. The details of structure, particularly in the female worm, require certain amendments in the generic concept.

3. The presence of Laurer's canal in *O. odhneri*, with a direct opening to the dorsal surface, makes it seem likely that the organ may actually function for the reception of sperm directly from the male worm.

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DESCRIPTION OF PLATE XIV

Fig. 1.—Male *Ornithobilharzia odhneri*, lateral aspect. $\times 44$.

Fig. 2.—Female *O. odhneri*, lateral aspect. $\times 44$.

Fig. 3.—Detail of female genital organs, *O. odhneri*. Greatly enlarged.

Legend.—*b*, excretory bladder; *g*, gut; *gp*, genital pore; *lc*, Laurer's canal; *o*, egg in *utero*; *oo*, ootype; *ov*, ovary; *sr*, seminal receptacle; *sv*, seminal vesicle; *t*, testes; *u*, uterus; *v*, vitelline follicles; *va*, vas deferens; *vd*, vitelline duct.

FAUST—ORNITHOBILHARZIA ODHNERI N. SP.

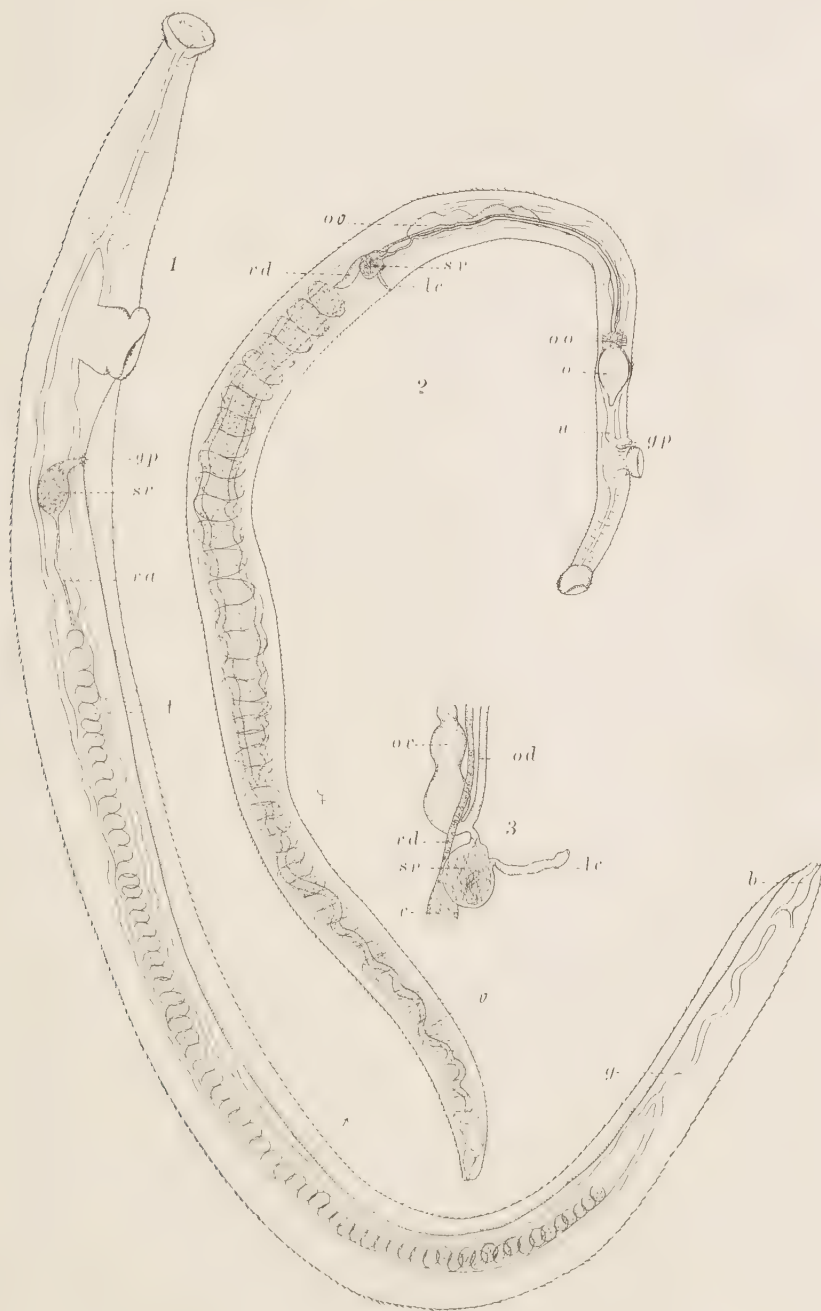


PLATE XIV

BOOK REVIEWS

MEDICAL AND VETERINARY ENTOMOLOGY. WILLIAM B. HERMS.
New York: The Macmillan Company, 1923. XIV + 462 pp. 229 figs.
Second edition, completely revised.

The second edition of Herms' Medical and Veterinary Entomology is not simply a reprint of the first edition. Every chapter shows evidence of thorough reconsideration and a painstaking effort to bring the subject matter up-to-date. While retaining the same general style and appearance, the volume has been increased from 393 to 462 pages. An especially valuable new feature is the historical outline occupying the first seven pages. The book is packed full of significant features in the remarkable rise of the science of medical entomology, forcefully and concisely stated, and accompanied by references to the original sources of all the data mentioned. Recent data are included dealing with the control of lice on man and other animals, their relation to typhus and trench fever, the use of male genitalia in the classification of mosquitoes, the overwintering of the malarial pathogens and their relation to different species of Anopheles, mosquito control, the control of house flies, the life cycle of the ox-warble, and the habits of chiggers.

Among the very few conspicuous omissions are an adequate presentation of the biology and the mouthparts of the Anoplura, the curious reproductive system of the bed bug, and a reference to the mercurial ointment for lice on fowls and the iodoform-vaseline ointment for the ox-warble. About twenty-five new illustrations are included with the omission of an equal number of the old ones. While most of the illustrations are excellent, figures 41, 94, 95, 99, 149, and 166 are weak, poor impressions; and the following leave much to be desired: figures 46, 49, 51, 70, 141, 152, 168, 185, 210, and 213. Typographical errors are few. One questions the author's use of the term "sexual maturity" on page 349, since the period to which he applies this term has been preceded by coition and the complete gestation of the first-born larva. One might also question the wisdom of devoting seven pages to the presentation of poliomyelitis, which has at best a doubtful insect connection, as against four pages to yellow fever and one to typhus fever. On the whole, however, excellent judgment has been used in the selection and omission of material from the really tremendous amount of literature dealing with this subject.

The second edition preserves all that was best in the first and embraces many improvements. The author's style is clear, forceful and convincing. The book is preeminently a usable text book and a splendid illustration of the increasingly common belief that a very practical subject can be treated in a thoroughly scientific manner.

STUDIES ON SCHISTOSOMIASIS JAPONICA. ERNEST CARROLL FAUST AND HENRY EDMUND MELENY. With a Supplement on the Molluscan Hosts of the Human Blood Fluke in China and Japan, and Species Liable to be Confused With Them. By NELSON ANNANDALE. Baltimore: American Journal of Hygiene, Monographic Series No. 3, 1924. XI + 339 pp. 25 figs. 36 pl.

Faust and Meleny's work is by far the most comprehensive publication which has yet appeared on the subject and sets a high standard for monographs in the field of applied helminthology. Chapter I gives a careful review of the historical aspects of the problem which is particularly valuable because many of the historically important data have heretofore been unavailable either because unpublished or because they had appeared only in Japanese literature. In succeeding chapters the authors present the results of their attempts to fill the gaps in

the knowledge of the disease and its causative organism. Their investigations have been carried on with particular reference to China, but consideration has also been given to other parts of the Orient. Chapter II covers the morphology, biology and life history of *Schistosoma japonicum*. In the third chapter the route of migration of the parasite in the mammalian host is discussed, and the conclusion expressed upon the basis of the authors' investigations that the main course taken by the young forms from the lungs to the liver, after they have entered the body through the skin and have reached the lungs, is by way of the pulmonary veins, systemic arterial circulation, gastro-intestinal capillaries, and mesenteric and portal veins, in which they thus agree with the findings of Miyagawa.

In their studies of the intermediate hosts (Chapter IV) the authors have discovered that the snails which act as intermediate hosts in China are *Oncomelania hupensis* in the regions about Soochow and Kashing, and *Katayama nosophora* in the Shaohsing area. The latter snail was found also in South China in the Pearl River delta but here the disease apparently has not yet become established and all snails examined proved to be uninfected. Among the thirteen Chinese provinces where the disease might be suspected to exist, nine have been found to have one or more definite areas of infection, the main territory of infection being the Yangtze basin. It seems probable that the infected areas in China cover ten times as much territory as the Japanese districts of infection, but are apparently much less heavily infected.

Clinical and laboratory findings in cases of schistosomiasis are given in Chapter VII together with a discussion of therapy. Antimony preparations were used successfully in the treatment in all three stages of infection, i. e. in the stage of invasion and maturation of the parasite, the stage of deposition and extrusion of eggs, and the stage of tissue reaction and repair. Intensive treatment, with proper precautions, is recommended. Chapter VIII discusses prophylaxis which is a problem of great magnitude and importance in the rice-growing regions of China. Under present conditions the authors consider it impracticable to attempt the Japanese method of control, namely eradication of the intermediate hosts and advocate the control of feces disposal, avoidance of wading in infected waters, protection of the skin by workers in rice nursery beds, and extensive treatment of the disease in out-patient clinics.

Attached as an appendix is a revision by the late Dr. Nelson Annandale of the molluscan hosts of *S. japonica* and of species likely to be confused with them. According to Annandale the species responsible in Japan for the transmission of the disease, first described by Robson in 1915 as *Katayama nosophora*, belongs to the genus *Oncomelania*. Whether or not a genus or subgenus, *Katayama*, distinct from *Oncomelania* may come to be recognized by specialists on mollusca, so that the name *Katayama nosophora*, already commonly used in medical literature, may be justified from a taxonomic standpoint, it appears certain from Annandale's studies that Robson's species is entirely distinct from *Blanfordia japonica* Adams, and that the genus *Blanfordia* has not yet been shown to be involved in schistosomiasis japonica.

In addition to literature references at the end of each chapter a complete bibliography of schistosomiasis japonica arranged chronologically is appended, and the volume is concluded by a carefully prepared index. Numerous original and generally well-executed illustrations, and good typography add to the usefulness of this valuable monograph.

GRUNDRISS DER THEORETISCHEN BAKTERIOLOGIE. By TRAUGOTT BAUMGÄRTEL. Julius Springer, Berlin, 1924, 259 pp.

This little book differs markedly from many of the texts appearing in the field of bacteriology; most recent additions to this type of literature deal with some phase of the practical applications of the bacteria in the arts or industries. Baumgärtel has treated the bacteria as living organisms and has

given practically no emphasis to what may be called industrial bacteriology. He opens the book with a detailed discussion of the structure of bacteria, following this with the usual physiology of the cell. The text is filled with new terms such as "hydromechanics of the bacterial cell," etc. Obviously in the number of pages given the author could not treat in extenso the various topics upon which there is considerable discussion today. The systematic arrangement of the whole book shows great labor and is admirable even though little mention is made of the organisms related to the bacteria. Numerous references are given in a section at the end of the book. It would have been more helpful to have had them at the bottom of the pages. The book is well printed and has a splendid index.

HUMAN PROTOZOOLOGY. By ROBERT W. HEGNER and WILLIAM H. TALIAFERRO. Macmillan Company, New York, 1924, 597 pp.

Recent years have seen the appearance of a considerable number of texts on Protozoa to which is added now a new one by two wellknown Johns Hopkins teachers and students of protozoology. The work includes primarily material given in the course in Protozoology in the School of Hygiene and Public Health at Johns Hopkins University. In comparison with some recent publications in this field it is marked by its limited size even though the volume reaches to 600 pages. The authors emphasize the necessity of selecting rigidly the material included in order to bring it within reasonable limits for the purpose in mind. The extraordinary attention to the field within recent years and the development especially of those groups of protozoa having a theoretical importance or practical bearing on human disease and public health have resulted in an increase in the literature to such dimensions that the subject is hardly handled within the limits of separate monographs and can with difficulty be held down to the scope of a textbook. Most previous contributions have been characterized by emphasis upon one phase or another of the subject. Students of biology have emphasized morphology and taxonomy, investigators in medical fields have laid stress upon relations to disease and life histories or transmitting agents. Others have contributed largely to the solution of questions of heredity, variation and cell structure by their researches on individual members of the group. The attempt to present a well balanced survey of the field encounters consequently serious difficulties which the authors in general have avoided well. Perhaps many will feel that their treatment of classification is a bit too autocratic and includes some rather extreme proposals yet they have merely followed their announced purpose of adopting the system utilized by workers in different groups introducing only minor modifications to adapt such systems to their purpose.

The scope of the book is well illustrated by a synopsis of the chapters which carry the following headings—Introduction to the Organization of the Protozoa, A General Consideration of the Sarcodina, The Ectozoic and Entozoic Sarcodina, A General Consideration of the Mastigophora, The Haemoflagellates and Allied Forms, The Intestinal Flagellates, A General Consideration of the Sporozoa, The Gregarines and Coccidia, The Order Haemosporidia Exclusive of the Malarial Parasites, The Malarial Parasites, The Neosporidia, A General Consideration of the Infusoria, Ectozoic and Entozoic Infusoria, Genetics and Physiology of Reproduction in the Protozoa, The Diagnosis of the Intestinal Protozoa. The work is well illustrated, the figures almost all of them new and good and with the text well printed. Even in a rapidly changing field the work is likely to remain for sometime a valuable contribution.

An important study of hookworm in Argentina has recently appeared by Dr. Raul F. Vaccarezza (*La Anquilostomosis en la Republica Argentina. La Semana Medica*, No. 21, Buenos Aires, 1924).

NEW HUMAN PARASITES

Gnathostoma hispidum.—A small piece of cutaneous tissue removed from a patient in the Surgical Clinic of Tokyo Imperial University contained a nematode. Moroshita who studied the parasite was able to determine it definitely as *Gnathostoma hispidum*, previously known to occur in the stomach wall of pigs and in one case in the fatty tissue of a cow. In the previously known human cases of *Gnathostoma* infection the species involved was *G. spinigerum*. In Moroshita's case the parasite caused typical lesions of creeping disease, *Dermatitis linearis migrans*. (Ann. Trop. Med. and Parasitol., 18:23-26, 1924.)

Hepaticola hepatica.—At the autopsy of a British soldier, aged 20, with four years' service, the last three of which were in India, an abscess was found in the liver. In proximity to the abscess were masses of eggs identified by W. P. MacArthur as those of *Hepaticola hepatica*; the worms themselves were also found in periphery of the lesion. The pathological sequence in this case appeared to be nematode infection, deposition of eggs in the liver, suppuration in situ, and secondary infection of the lungs, that is, a condition of pyemia resulting in death. This parasite, common in rats, has not heretofore been recorded as a human parasite. (Dive and Lafrenais, J. Roy. Army Med. Corps, 43: 1-4, 4 figs., 1924.)

Karyamoeba falcata Kofoid & Swezy, 1924.—Three instances of the occurrence in human feces of an amoeba representing a new genus and species are recorded. It appears to be a persistent inhabitant of the human intestine and not a mere coprophile. It resisted treatment and was accompanied by no signs of pathogenicity. It occurred only in the motile phase. There are one, rarely two or three blunt hyaline pseudopodia. Ectoplasm and endoplasm are sharply separated. There is a heavy peripheral pellicle. The endoplasm is more granular than the ectoplasm, coarsely vacuolated; the vacuoles rarely contain food bodies. The nucleus contains one or two, rarely more, large crescentic, siderophile masses, applied to the nuclear membrane, with little peripheral chromatin besides applied to the membrane. A spherical excentric karyosome in a halo is present, and sometimes adjacent to it a minute centriole. There is no concentric zoning of the intermediate region. Mitosis proceeds by the emergence of polar caps, the division of the centriole and migration of the daughters to the poles over the outside of the polar caps. The centrioles on the summits of the polar caps are joined by a slender, thread-like, meridional intradesmose. Chromosomes emerge as elongated masses in the area between the polar caps. These shorten up into two rows in an end-to-end arrangement in the amphiaster stage. There are approximately twenty chromosomes. Mitosis is of the Vahlkampfia type. (Univ. Calif. Pubs. Zoology, 26: 221-242; 2 pls., 2 text-figs. June 24, 1924.)